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# Water Quality Survey Blacktail Unit

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DILLON RESOURCE AREA RESOURCES INVENTORY:

WATER QUALITY SURVEY Blacktail Unit

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## ACKNOWLENGER ENTE

# TABLE OF CONTENTS

INTRODUCTION
METHOD
Inventory Design
Field Methods
Laboratory Methods
Analytical Methods
STUDY AREA
Beaverhead County
Blacktail Creek Watershed p. 1
Lower Blacktail Station
Upper Blacktail Station
Indian Station
Clark Canyon Creek Watershed
Lower Clark Canyon Station
Upper Clark Canyon Station
East Fork Clark Canyon Station
Little Sage Creek Watershed
Little Sage Creek Station
Basin Creek Watershed
Lower Basin Creek Station
Upper Basin Creek Station
Little Basin Creek Station
RESULTS AND DISCUSSION
Blacktail Creek Basin

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	Channel Stability Ratings											p.	30
	Precipitation											р.	30
	Stream Discharge					•						p.	35
	Suspended Sediment	•										р.	45
	Hydrochemical Parameters											р.	50
	Bacteria Levels											р.	50
	Comments											р.	55
Clark	Canyon Creek Basin	•			•							р.	57
	Channel Stability Ratings				•							р.	57
	Precipitation								•			р.	57
	Stream Discharge			•	•						•	р.	62
	Suspended Sediment	•										р.	70
	Hydrochemical Parameters											р.	72
	Bacteria Levels			•								р.	76
	Comments											p.	82
Littl	le Sage Creek Basin		• ,							•		p.	82
	Channel Stability Rating											р.	82
	Precipitation											р.	84
	Stream Discharge											р.	84
	Suspended Sediment									•		р.	89
	Hydrochemical Parameters											р.	91
	Bacteria Levels	•										р.	91
	Comments											р.	93
Basir	n Creek Basin	•									•	р.	93
	Channel Stability Ratings											р.	96
	Precipitation						•					р.	96
	Stream Discharge											р.	96

								Precipitation
		,						

Suspended Sediment .				•	•	•	•			•	•			•	•		p.	110
Hydrochemical Paramet	ers	3								•					•		p.	112
Bacteria Levels	٠	•		•	•		•		•	•							p.	119
Comments	•	•					•										p.	122
LITERATURE CITED	•		•		•								•	٠		•	р.	123
APPENDIX - DATA																		
Lower Blacktail		•					•		•			•					р.	125
Upper Blacktail	•	•							•	•						•	p.	129
Indian		•			•			•									р.	133
Lower Clark Canyon																	р.	137
Upper Clark Canyon	•	•			•					•	•						p.	141
East Fork Clark Canyon	•											•		•	•		р.	145
Little Sage																	р.	149
Lower Basin	•				•												р.	153
Upper BAsin																	p.	157
Little Racin																	D	161



# FIGURES

Figure 1	Blacktail Creek Watershed Location 16
Figure 2	Blacktail Station Locations p. 18
Figure 3	Clark Canyon Watershed Location
Figure 4	Clark Canyon Station Locations
Figure 5	Little Sage Watershed Location p. 23a
Figure 6	Little Sage Station Locations
Figure 7	Basin Creek Watershed Location
Figure 8	Basin Creek Station Locations
Figure 9	Upper Blacktail Precipitation Datap. 34
Figure 10	Lower Blacktail Staff-discharge Rating Curve p. 36
Figure ll	Upper Blacktail Staff-discharge Rating Curve p. 37
Figure 12	Indian Staff-discharge Rating Curve p. 38
Figure 13	Lower Blacktail Hydrograph - 1977
Figure 14	Lower Blacktail Hydrograph - 1978 p. 40
Figure 15	Upper Blacktail Hydrograph - 1977 p. 41
Figure 16	Upper Blacktail Hydrograph - 1978
Figure 17	Indian Hydrograph - 1977 p. 43
Figure 18	Indian Hydrograph - 1978
Figure 19	Lower Blacktail Sediment vs Discharge
Figure 20	Upper Blacktail Sediment vs Discharge
Figure 21	Indian Sediment vs Discharge
Figure 22	Lower Blacktail Conductivity vs Discharge p. 51
Figure 23	Upper Blacktail Conductivity vs. Discharge p. 52
Figure 24	Indian Conductivity vs Discharge
Figure 25	East Fork Clark Canyon Precipitation Data p. 61
Figure 26	Lower Clark Canyon Staff-discharge Rating Curve p. 63



^	,
/	h

Figure 27	Upper Clark Canyon Staff-discharge Rating Curve p. 6	54
Figure 28	Lower Clark Canyon Hydrograph - 1977	55
Figure 29	Lower Clark Canyon Hydrograph - 1978 p.	66
Figure 30	Upper Clark Canyon Hydrograph - 1977	67
Figure 31	Upper Clark Canyon Hydrograph - 1978 p.	68
Figure 32	East Fork Clark Canyon Hydrograph 1978	69
Figure 33	Lower Clark Canyon Sediments vs Discharge · · · · · P·	73
Figure 34	Upper Clark Canyon Sediment vs. Discharge · · · · · P·	74
Figure 35	East Fork Clark Canyon Sediment vs Discharge P.	75
Figure 36	Lower Clark Canyon Conductivity vs. Discharge p.	77
Figure 37	Upper Clark Canyon Conductivity vs. Discharge p.	78
Figure 38	East Fork Clark Canyon Conductivity vs. Discharge p.	79
Figure 39	Little Sage Precipitation Data	85
Figure 40	Little Sage Staff-discharge Rating Curve p.	86
Figure 41	Little Sage Hydrograph - 1977	87
Figure 42	Little Sage Hydrograph - 1978	88
Figure 43	Little Sage Sediment vs Discharge	90
Figure 44	Little Sage Conductivity vs. Discharge p.	92
Figure 45	Upper Basin Precipitation Data p. 1	00
Figure 46	Lower Basin Staff-discharge Rating Curve p. l	01
Figure 47	Upper Basin Staff-discharge Rating Curve $\dots$	02
Figure 48	Little Basin Staff-discharge Rating Curve p. 1	03
Figure 49	Lower Basin Hydrograph - 1977 p. 1	04
Figure 50	Lower Basin Hydrograph - 1978 p. 1	05
Figure 51	Upper Basin Hydrograph - 1977 p. l	06
Figure 52	Upper Basin Hydrograph - 1978 p. 1	07



Figure 53	Little Basin Hydrograph - 1977	•	•	•	•	•	٠	•	р.	108
Figure 54	Little Basin Hydrograph - 1978		•						р.	109
Figure 55	Lower Basin Sediment vs Discharge		•						p.	113
Figure 56	Upper Basin Sediment vs Discharge		•			•			p.	114
Figure 57	Little Basin Sediment vs Discharge				•	•			р.	115
Figure 58	Lower Basin Conductivity vs Discharge .		•			•			p.	116
Figure 59	Upper Basin Conductivity vs. Discharge.	•	•						р.	117
Figure 60	Little Basin Conductivity vs. Discharge								p.	118



# **TABLES**

1.	Lower Blacktail Channel Stability p.	31
2.	Upper Blacktail Channel Stability p.	32
3.	Indian Channel Stability p.	33
4.	Blacktail Station Water and Sediment Yields p.	45
5.	Blacktail Station Hydrochemistry	54
6.	Blacktail Station Bacteria Countsp.	56
7.	Lower Clark Canyon Channel Stability p.	58
8.	Upper Clark Canyon Channel Stability p.	59
9.	East Fork Clark Canyon Channel Stability p.	60
10.	Clark Canyon Station Water and Sediment Yields p.	71
11.	Clark Canyon Station Water and Sediment Yields p.	80
12.	Clark Canyon Station Bacteria Counts	81
13.	Little Sage Channel Stability p.	83
14.	Little Sage Hydrochemistry p.	93
15.	Little Sage Bacteria Counts	95
16.	Lower Basin Channel Stability	97
17.	Upper Basin Channel Stability p.	98
18.	Little Basin Channel Stability	99
19.	Little Sage and Basin Water and Sediment Yields p.	111
20.	Basin Hydrochemistry	: 20
21	Rasin Ractoria Counts	121



## INTRODUCTION

Watershed managers have traditionally been concerned with the quality of the waters that leave a watershed. As man modifies watersheds by various land use practices, disequilibrium in both the terrestrial and aquatic environments occurs. Problems result in controlling accelerated sediment and nutrient release from non-point sources within the basin. Stream water samples provide the investigator with insights into the general health of the patient. In an attempt to reduce watershed degradation, Congress recently mandated that local and regional agencies and authorities gather and assess environmental data for the lands and waters under their jurisdiction and authority. The Federal Water Pollution Control Act

Amendments of 1972 (Public Law 92M-500) was promulgated to require:

1) the assessment of the sources and extent of non-point pollution, and

2) the development of methods and procedures for controlling non-point

pollution resulting from agricultural and silvicultural activities (FWPCAA,

1972).

In April, 1976, personnel from the Montana Forest and Conservation Experiment Station began a resource inventory in southwest Montana for the Bureau of Land Management. This integrated resources inventory was designed by Bureau personnel to provide environmental data on watershed, wildlife, and range resources within portions of Beaverhead, Deer Lodge, Madison and Silver Bow counties near Dillon, Montana. More specifically, the National Resource Lands in the Rochester, Blacktail, Tendoy Mountains, Dillon West, and Centennial Planning Units were inventoried. The environmental data obtained is to be incorporated into the Bureau's Planning System and into the Mountain Foothills Range Environmental Impact Statement.



The water quality study portion of the above resource inventory project included the monitoring of 42 temporary stream sampling stations located in 17 drainage basins within the inventory area. Stream discharge, suspended sediment, hydrochemical values and bacteria levels were monitored at each sampling station for the 1977 and 1978 hydrologic years. In addition, the macrobenthic invertebrate communities at each station were sampled, the results of which are reported elsewhere. This volume presents the results of the water quality study for Blacktail Planning Unit which inclues East Fork Blacktail Deer, Indian, Clark Canyon, East Fork Clark Canyon, Little Sage, Basin and Little Basin creeks.



#### **METHOD**

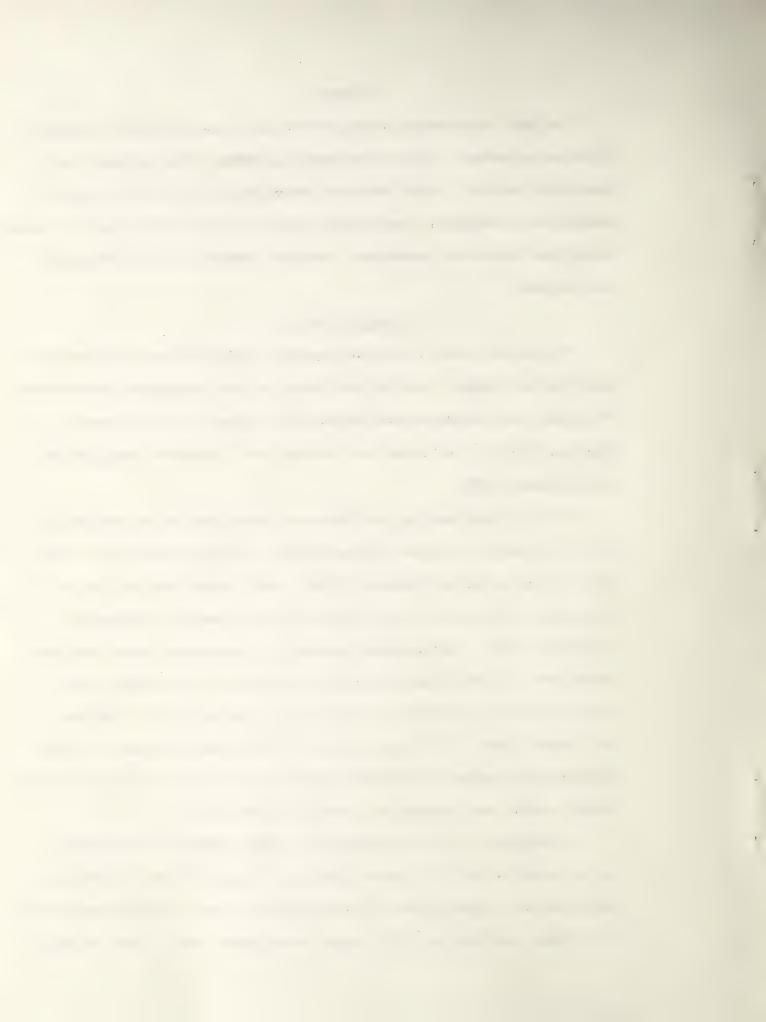
The basic experimental design of the water quality study, developed by Bureau personnel, includes the sampling scheme, field methods, and laboratory methods. Minor additions and modifications to the original design were subsequently incorporated into the study as field and laboratory conditions dictated or permitted. Specific comments on such alterations are included.

# Inventory Design

The initial phase of the water quality study involved a stream reach inventory and channel stability evaluation of each designated stream reach. The method and procedures used during this evaluation are outlined in Pfankuch (1975). The stream reach ratings were completed during August and September, 1976.

The 42 stream sampling stations were established during September, 1976. The selection of each gaging station site was governed by criteria presented in Carter and Davidian (1968). Each stream sampling station included a staff gage, a crest-stage gage, and a max-min thermometer. A standard 3.3ft. staff gage was mounted to a fence post driven into the stream bed. A crest-stage gage was constructed of 3/4" diameter clear acrylic tubing, using modifications of the plans set forth in Buchanan and Somers (1968). This gage was afixed to the staff gage and fence post. The max-min thermometer was bolted within a piece of PVC pipe, laid on the stream bottom, and attached by a chain to a fence post.

In addition, a 15 unit precipitation gage network was established in the spring of 1977. A general purpose rain gage (forester type) was installed in a plywood frame at each designated sample location and placed in a clear, open site at a 12" height above ground level. This technique



conforms with that recommended by the World Meteorological Organization (World Meteorological Organization, 1969, as cited in Aldridge, 1976).

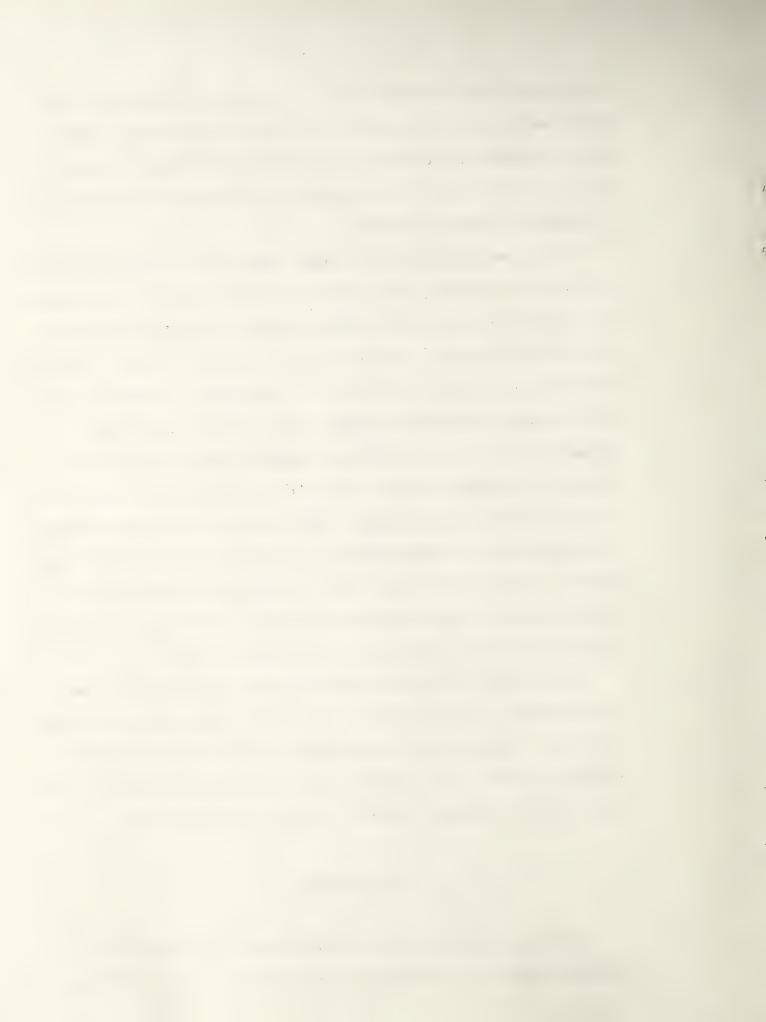
Such a placement minimizes the error caused by wind eddying (Stringer, 1972, p. 29; Aldridge, 1976), and reduces the probability of disturbance or damage by livestock or vandals.

The stream and precipitation gage networks were monitored during the 1977 and 1978 hydrologic years. The basic design called for all stations to be visited on a prescribed schedule of weekly during peak runoff and monthly during low flow. The field seasons included: October - November, 1976; February and April - November, 1977; and March - September, 1978. The following water quality parameters were monitored as applicable. During each visit; stream discharge, suspended sediment, specific conductance, air temperature, water temperature, max-min water temperature, and precipitation were determined. Once a month, a water quality sample was taken for the following analyses; pH, alkalinity, calcium, magnesium, sodium, potassium, bicarbonate, sulfate, ammonia, nitrite-nitrate, and ortho-phosphate. A second stream water sample was obtained for bacterial analysis to determine levels of total and fecal coliform.

Macrobenthic invertebrate inventories were also conducted at each stream sampling station during May, July, and September of each hydrologic year. Four individual square foot samples for the smaller streams and 6 samples for the larger streams were obtained during 1977, while 2 and 4 samples respectively were obtained for the streams during 1978.

# Field Methods

Discharge values were determined by standard techniques using procedures described in Buchanan and Somers (1968). Stream velocities

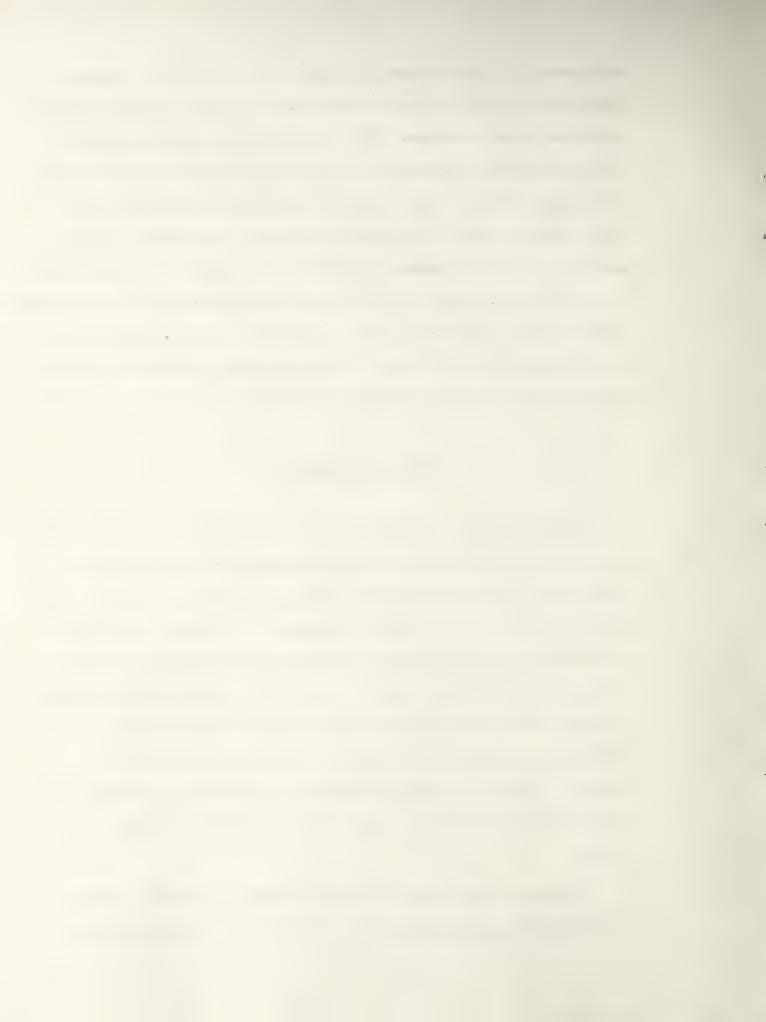


were taken with a Gurley Pygmy type model 625 current meter. Sediment samples were obtained with a US DH-48 sediment sampler in conformance with procedures in Guy and Norman (1970). Water temperatures were recorded from Taylor max-min thermometers. Precipitation was collected in standard 7" rain gage (forester type). Specific conductance was measured with a Delta Scientific Model 1914 conductivity meter. Hydrochemical samples were collected in acid washed polyethylene liter bottles, which were filled to exclude air, and stored in an ice chest during transport to the laboratory. Microbiological samples were collected in 250 ml sterilized glass bottles and also stored in the ice chest. The macrobenthic invertebrate samples were taken with a Kahlsico stream-bed fauna sampler.

## Laboratory Methods

Immediately upon arrival at the Dillon laboratory, each sample bottle was opened and an unfiltered sample was analyzed for pH and alkalinity respectively. The values obtained closely represent the values at the time of collection in the field (Brown, Skougstad, and Fishman, 1970, p. 129), while minimizing the potential for instrument damage during transport or carriage over back country roads or trails. This method has been adopted by several USDA Forest Service personnel (Aubertin, 1974; Snyder, et al., 1975). PH was measured using an Orion pH probe and an Orion 407 ion analyser. Akalinity was then determined by potentiometric titration to a preselected end point with a standard acid, as outlined in Brown, et al., (1970).

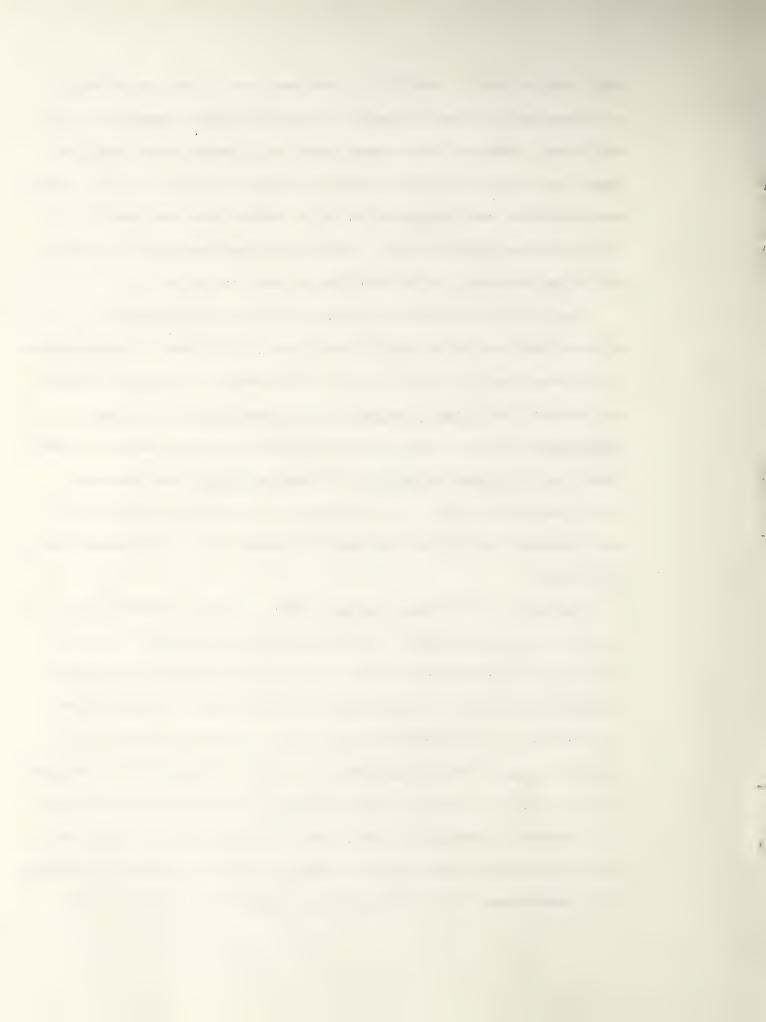
A 100 milliliter aliquot for ammonia analysis was then acidified with 0.8 milliter concentrated sulfuric acid and refrigerated (American



Public Health Assoc., 1976, p.42). The remainder of each stream sample was subsequently filtered through a 0.45 µm (micrometer) membrane filter and frozen. Membrane filters were soaked for 24 hours before using to remove any traces of soluble phosphate or nitrate (A.P.H.A., 1976 p. 472). Ammonia samples were analyzed on an Orion Ammonia electrode, model 95-10 (Orion Research Incorp., 1974). This analysis was routinely preformed in the Dillon laboratory on the final day of field collection.

Upon return to the Missoula laboratory the frozen samples were defrosted for analysis in the following order; 1) filterable orthophosphate; 2) nitrite-nitrate; 3) sufate; and 4) common metals. Procedures followed were adapted from Standard Methods for the Examination of Water and Wastewaters (A.P.H.A, 1976), with the exception of nitrate which was taken from Methods for Chemical Analysis of Water and Wastes (Environmental Protection Agency, 1976). All colorimetric tests were preformed on a dual beam spectrophotometer (Beckmann ACTA model III). All glassware was acid washed.

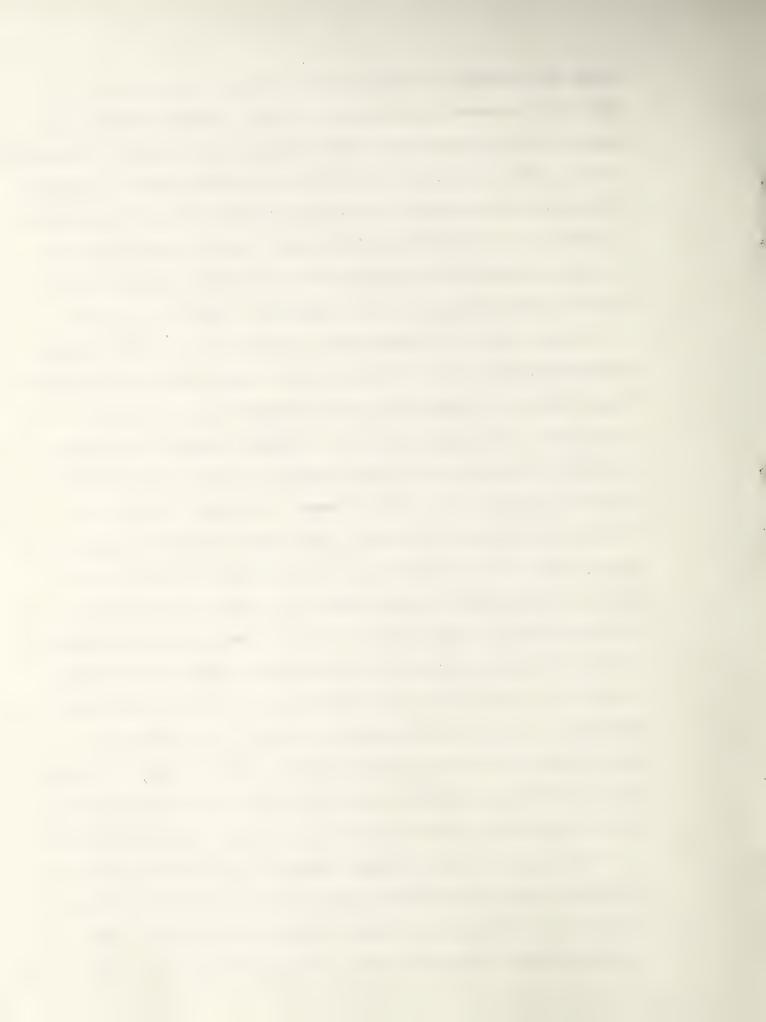
The Asorbic Acid method, procedure 425F, (A.P.H.A., 1976) was used for dissolved orthophosphate. Results are expressed as PO<sub>4</sub>-P. Nitrite and nitrate were determined collectively since nitrite usually occurs in insignificant amounts in uncontaminated surface waters. The sum of the two represents total oxidized nitrogen and is expresses as nitrite plus nitrate-nitrogen. The Cadmium Reduction Method (E.P.A., 1976) was selected because of its low detection limits (10 µg/l). Sulfate was measured using the turbidimetric method, procedure 427C, (A.P.H.A., 1976). During the 1977 field season measurements were made on a spectrophotometer, but during 1978 a nephelometer (Turner Designs, Inc., medel #40) was used. Both



methods are recommended in the procedure, although it was found the nephelometer increased the precision of the test. Sodium, potassium, magnesium and calcium were run in that order by atomic absorption spectroscopy (A.P.H.A., 1976) using a Varian Techtron AA-5 spectrophotometer. Lanthanum chloride solution was added to the samples for magnesium and calcium analyses to prevent anionic interferences (EPA, 1976). Total dissolved solids and bicarbonate concentrations were determined from specific conductance and alkalinity values using calculations presented in Brown, et al., (1970).

Nitrogen levels, ie. ammonia and nitrite-nitrate, are consistantly at the minimum detection limit of the analysis. Ammonia levels are particularly suspect owing to the limitations of the instrument and the technique for the analysis. In interpreting results of ammonia analysis; a presence or absence of detectable ammonia approach should be used. Thus high levels of ammonia indicate that a source of ammonia is present in addition to those which are naturally occurring. Such levels are usually transitory and may vary in order of magnitude. Nitrite - nitrate values are also near the minimum detection limit; however, the nature of this analysis yields more precise results. These values, as a whole, tend to be generally lower than those expected under the environmental conditions encountered. Low phosphate values are to be expected and were confirmed by this study. The method for phosphate analysis selected is the procedure generally used when working in this low range of values. The other ions, ie. sulfate and the common metals, tended to be present in sufficient quantities so that no problems were encountered owing to the sensitivity of the analyses.

Water samples for microbiological examination were analyzed within six hours of collection (Millipore, 1975a). Fecal coliform were cultured, identified, and enumerated throughout the study by the membrane filter method described by Millipore (1975b). Total coliform bacteria were cultured,



identified, and enumerated by the membrane filter method (Millipore, 1975a), but with the modifications outlined below.

Total coliform data for 1977 were determined by counting the number of wet colonies that exhibited a visible green metallic sheen, either to the naked eye or at 1.5x magnification. Millipore (1975a) recommends the use of a 10x magnification dissecting microscope and that the colonies be dry. Geldreich (1975), however, indicates that there is no significant advantage to drying the colonies before counting. Without the 10x magnification, however it is probable that colonies growing close together were mistaken as being one colony, and colonies having a weak metallic sheen were not counted at all. This procedure would result in data that would underestimate the number of total coliform colonies present.

A modification of the membrane filter method was adopted in 1978 to minimize the problem of underestimating the total coliform colonies. In the previous year, only the wet colonies exhibiting a distinct green metallic sheen were designated as coliform bacteria (Millipore, 1975a), while those wet colonies having a "non-sheen" red color darker than the medium-permeated background had not been counted. The degree of pigmentation and sheen development of coliform colonies grown on M-Endo medium, however, is variable according to both species and biotype. Furthermore, the identification criteria, i.e. colonies having a green iridescence or metallic sheen, is highly subjective and may vary from technician to technician. Thus, some authors admit that "questionable colonies" may occur which need more technical procedures for verification. One such procedure is to inoculate questionable colonies into a lactose broth, incubate at 35°C. for 48 hours, and determine whether gas and acid have been produced (Geldreich, 1975).



Using the above technique, an estimate of the fraction of questionable colonies was determined for which the lactose test was positive. After testing a series of 26 non-sheen, red colonies representing a variety of recognizable colonial morphotypes from several different stations, 69 percent were found to be lactose positive within 48 hours. Additionally, 16 percent of all dark red colonies found on 369 membrane filter samples exhibited a characteristic green sheen. It was thus estimated that approximately 75 percent of all red colonies darker than their membrane filter background conformed to either the green-sheen or lactose-test definitions of coliform bacteria. During the 1978 field season, all red colonies, sheen and nonsheen darker than their membrane filter background that were detected with the use of 10x magnification dissecting microscope were counted as total coliform. This procedure had the potential of overestimating the bacterial count by approximately 30 percent. It should be emphasized, however, that bacterial counts are not absolute values, but only estimates of magnitudes. Geldreich (1966, p.35) evaluated the total coliform bacteria for 40 samples using both the membrane filter method and the "most probable number" method. The ratio of their results varied from a minimum of 0.42 to a maximum of 2.52 respectively.

Tabulated total and fecal coliform data for this study are expressed as arithmetic means of either two or three replicated subsamples. A shough the total coliform levels for the 1977 field season, i.e. May through November, 1977, are underestimated, the fecal coliform data for the two years are commensurate.



# Analytical Methods

Stream discharge values were determined from field data with the use of a computer program based upon the procedure outlined in Buchanan and Somers (1969). These measured discharge values were then used to generate a staff-discharge rating curve for each station using a linear regression program. In several instances, two rating curves were produced. Instant and crest stage discharge values for the two water years were then estimated from the respective staff-discharge rating curves.

The annual hydrograph and sediment loading graphs were plotted with a computer using field data. Missing data points, i.e. winter months, were estimated using available stream flow, precipitation, and sediment concentration data. Estimates of annual water yield and annual sediment yield were generated by a modification of the computer program used to determine stream discharge. In a few instances, unusually high or questionable sediment concentration values, apparently caused by cattle present within the stream environs at the time of sampling or by sampling or analytical error, represented long sampling periods, i.e. 30 days. Where such conditions occurred, an estimated "corrected" level was substituted inorder to generate a more approximate determination of the annual sediment yield. The relationships between measured values of suspended sediment vs stream discharge and specific conductance vs stream discharge were determined by linear regression and plotted using the computer programs.

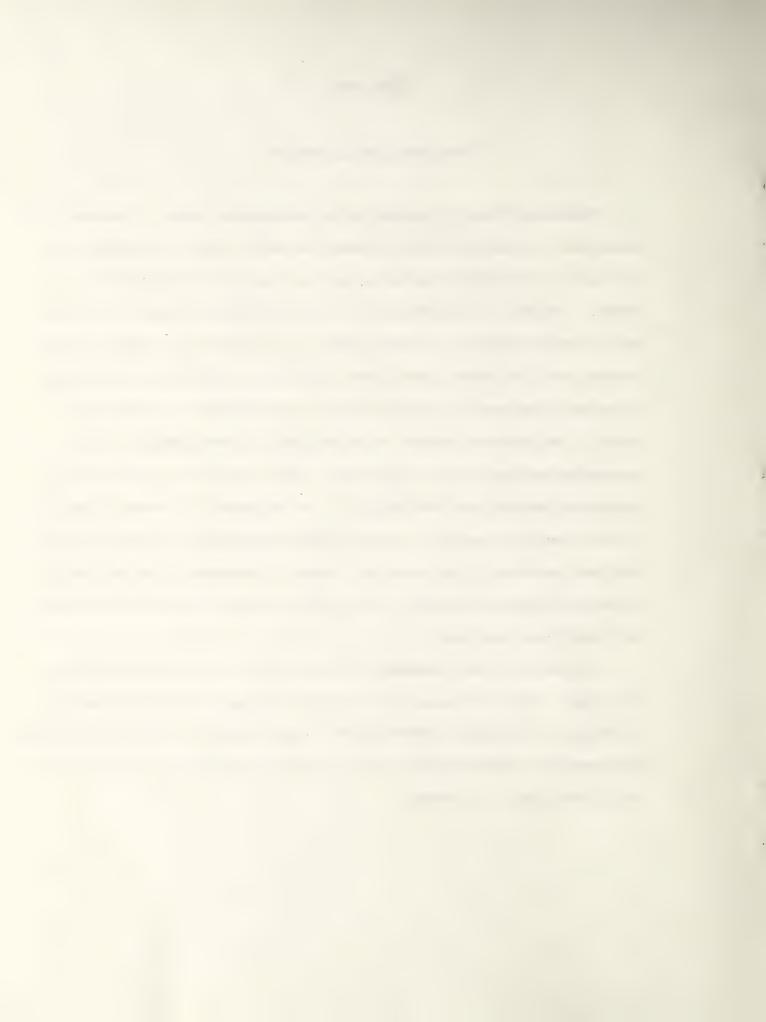


#### STUDY AREA

# Beaverhead County, Montana

Beaverhead County is located in the southwestern corner of Montana immediately southwest of Butte. Almost the entire county lies above 5,000 feet and is encircled on the north, west and south by the Continental Divide. The area is characterized by broad grassland and sagebrush covered valley bottoms and river terraces, while the flanks of the numerous mountain ranges grade into forest lands. The westernmost headwaters of the Missouri River drain the county to the northeast via the Big Hole and Beaverhead rivers. The forested mountain areas are generally administered by the Beaverhead National Forest of the USDA, Forest Service; the lower mountain slopes and terrace lands are managed by the Department of Interior's Bureau of Land Management; while the valley bottoms are mainly in private holdings. The land resources of the county are primarily allocated to the raising of livestock, although lumbering, mining, and recreation constitute secondary, but significant land uses.

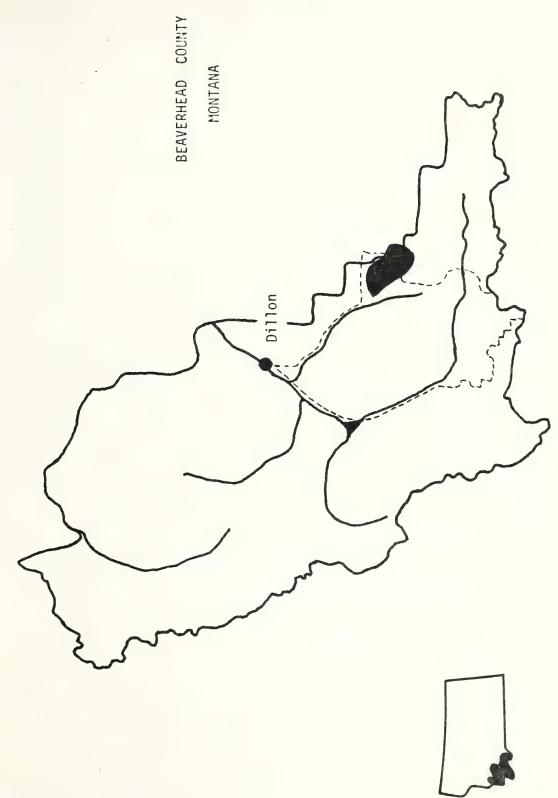
The Bureau of Land Management's district office is located in Dillon, the county seat. The county contains five planning units administered by the Bureau. The Blacktail Planning Unit lies southeast of Dillon and includes the East Fork of Blacktail Deer Creek, Clark Canyon Creek, Little Sage, and Basin Creek sample watersheds.



#### Blacktail Creek Watershed

The Blacktail Creek sample basin encompasses the nearly 29,200 acres of the East Fork Blacktail Deer Creek watershed that lie upstream of the bridge crossing in Section 6, Township 11S, Range 5W (Figure 1). This study area includes the Lower Blacktail discharge monitoring sub-station, the Lower Blacktail water quality monitoring sub-station, and the Upper Blacktail and Indian stations. Local relief in this predominantly northwest facing basin ranges from approximately 6,800 feet to 10,600 feet elevation. The upper basin is mountainous and includes several valleys confined by high steep slopes. The lower portion of the basin is open and composed of rolling hills and partially dissected terraces lying above the broad floodplain. The geology of the upper valley includes a complex of calcareous and non-calcareous sedimentary and metasedimentary materials and associated igneous intrusives. The lower valley is largely composed of Tertiary sediments. The mountainous areas are dominated by entisols, inceptisols, talus deposits, and rock outcrops. The lower valley is characterized by mollisols. The lower and middle slopes of the mountains are covered with forests, the higher slopes are thinly forested or above the effective treeline. The lower valley is covered with sagebrush and grassland communities. Approximately 50 percent of the sample basin is administered by the Beaverhead National Forest, 35 percent is controlled by either the State of Montana or in private holdings, and the remaining 15 percent is managed by the Bureau of Land Management. Portions of the lower basin are administered by the Montana Department of Fish and Game as an elk winter range. The middle portion of the watershed is allocated for livestock grazing, while both the middle and upper reaches are used for recreational pursuits.





Location of Blacktail Creek Sample Basin, Blacktail Planning Unit, Beaverhead County, Montana. Figure 1.

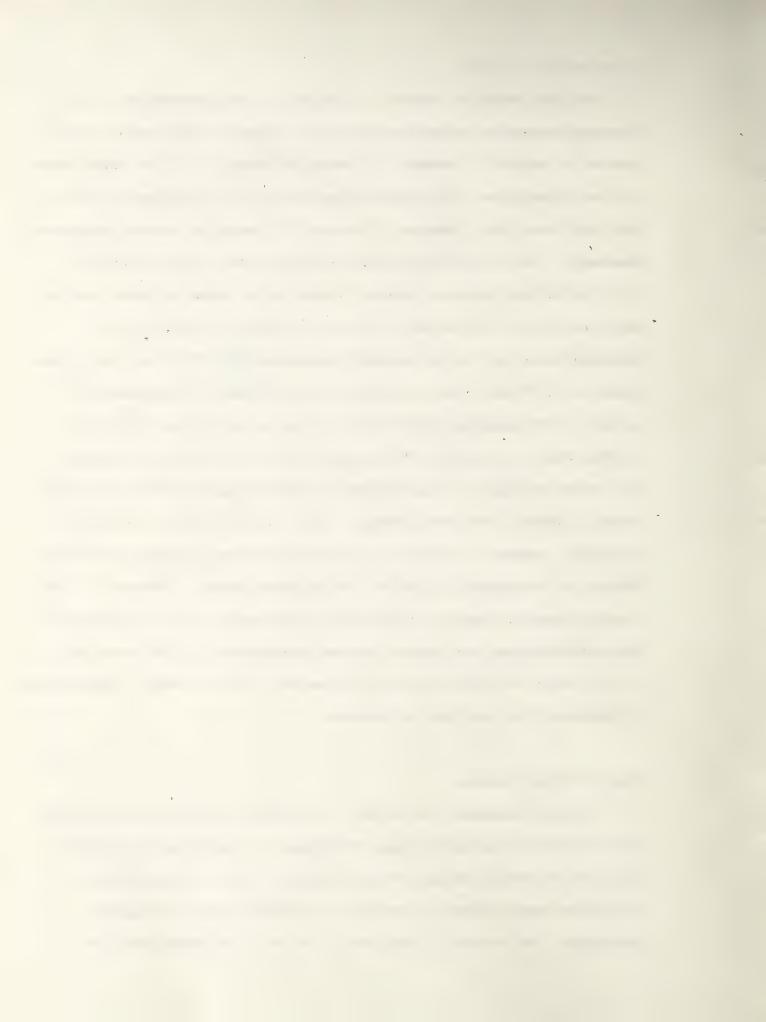


#### Lower Blacktail Station

The Lower Blacktail station is divided into two sub-stations. The discharge monitoring sub-station No. 8(B) is located in the south central portion of Section 6, Township 11S, Range 5W (Figure 2), at the bridge where the road crosses East Fork Blacktail Deer Creek. This location is found on the Price Creek, N.E., Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 8B on aerial photo No. 5-119-147 of this resource inventory report and is shown on stream station photo No. 8(B)A. The station is located at 6,780 ft. elevation. The watershed above the station contains approximately 29,200 acres, has a local relief of 3,800 feet, and is oriented to the northwest. Approximately 50 percent of the watershed is forested. The water quality monitoring substation 8(A), is located in the northeast portion of Section 28, Township 11S, Range 5W (Figure 2), approximately 50 yards downstream from an unnamed drainage entering from the southwest. This location is found on the Price Creek N.E., Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 8A on aerial photo No. 14-120-73 of this resource inventory report. The station is located at 7,120 ft. elevation. The watershed above the station contains approximately 18,600 acres, has a local relief of 3,500 feet, and is oriented to the northwest. Approximately 75 percent of the watershed is forested.

# Upper Blacktail Station

The Upper Blacktail station No. 6 is located in the southwest portion of Section 35, Township 11S, Range 5W (Figure 2), approximately 400 yards below the Beaverhead National Forest boundary. This location is found on the Antone Peak, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 6 on aerial photo No.



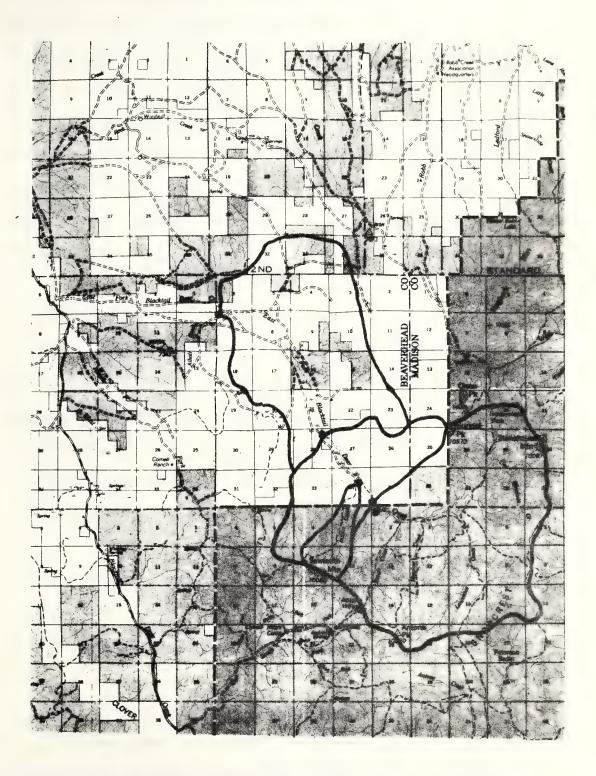


Figure 2. Locations of the Blacktail Creek Sampling Stations.



14-120-73 of this resource inventory report, and is shown on stream station photo no. 6A. The station is located at 7,350 ft. elevation. The watershed above the station contains approximately 13,900 acres, has a local relief of 3,100 feet, and is oriented to the northwest. Approximately 90 percent of the watershed is forested.

The Upper Blacktail precipitation station No. 6G is located in the southwest portion of Section 35, Township 11S, Range 5W (Figure 2), approximately 100 yards upstream from sample station No. 6, between the creek and the upper end of the beaver pond. It is depicted as site No. 6G on aerial photo No. 14-120-73 of this resource inventory report.

#### Indian Creek Station

The Indian Creek station No. 7 is located in the central portion of Section 34, Township 11S, Range 5W (Figure 2), approximately 50 yards upstream from where the road crosses Indian Creek. This location is found on the Antone Peak, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 7 on aerial photo No. 14-120-73 of this resource inventory report, and is shown on stream station photo no. 7A. The station is located at 7,310 ft. elevation. The watershed above the station contains approximately 1,100 acres, has a local relief of 2,800 feet, and is oriented to the north-northeast. Approximately 90 percent of the watershed is forested.

# Clark Canyon Creek Watershed

The Clark Canyon Creek sample watershed (Figure 3) includes the Lower Clark Canyon, the Upper Clark Canyon, and the East Fork Clark Canyon sampling stations. This west-northwest oriented basin encompasses approximately



9,700 acres. Local relief in this steep and rugged basin ranges from nearly 5,650 feet to almost 8,900 feet. The basin's complex geology includes fine and course textured sedimentary materials, Tertiary sediments, as well as ash and mudflow deposits. The soils include inceptisols, mollisols, and alfisols. Grassland and sagebrush communities dominate the lower and midportions of the basin, while forests are found at favorable sites in the middle and upper reaches. The Bureau of Land Management administers approximately 65 percent of the watershed, 25 percent is in private holdings, while the remaining 10 percent belongs to the State of Montana. The basin is predominantly used for livestock grazing.

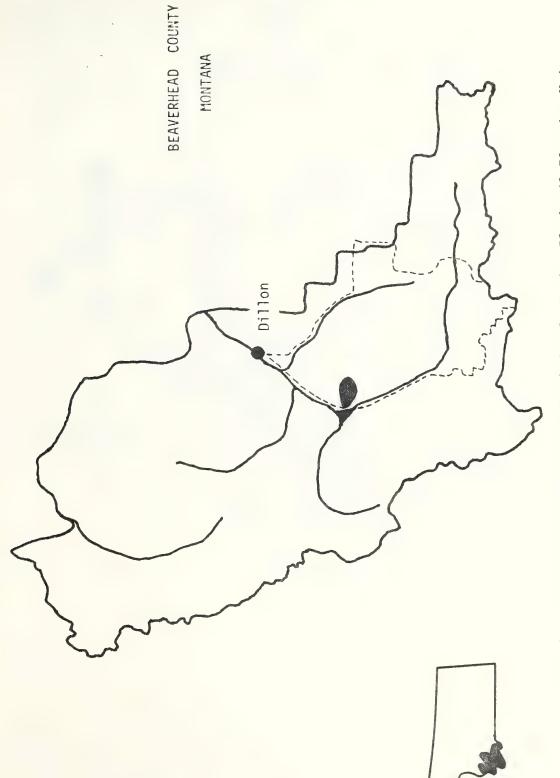
### Lower Clark Canyon Station

The Lower Clark Canyon station No. 11 is located in the west central portion of Section 35, Township 9S, Range 10W (Figure 4), approximately 100 yards upstream from the section line. This location is found on the Dalys, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 11 on aerial photo No. 4-116-24 of this resource inventory report, and is shown on stream station photo no. 11A and 11B. The station is located at 5,640 ft. elevation. The watershed above the station contains approximately 9,700 acres, has a local relief of 3,200 feet, and is oriented to the west-northwest. Approximately 10 percent of the watershed is forested.

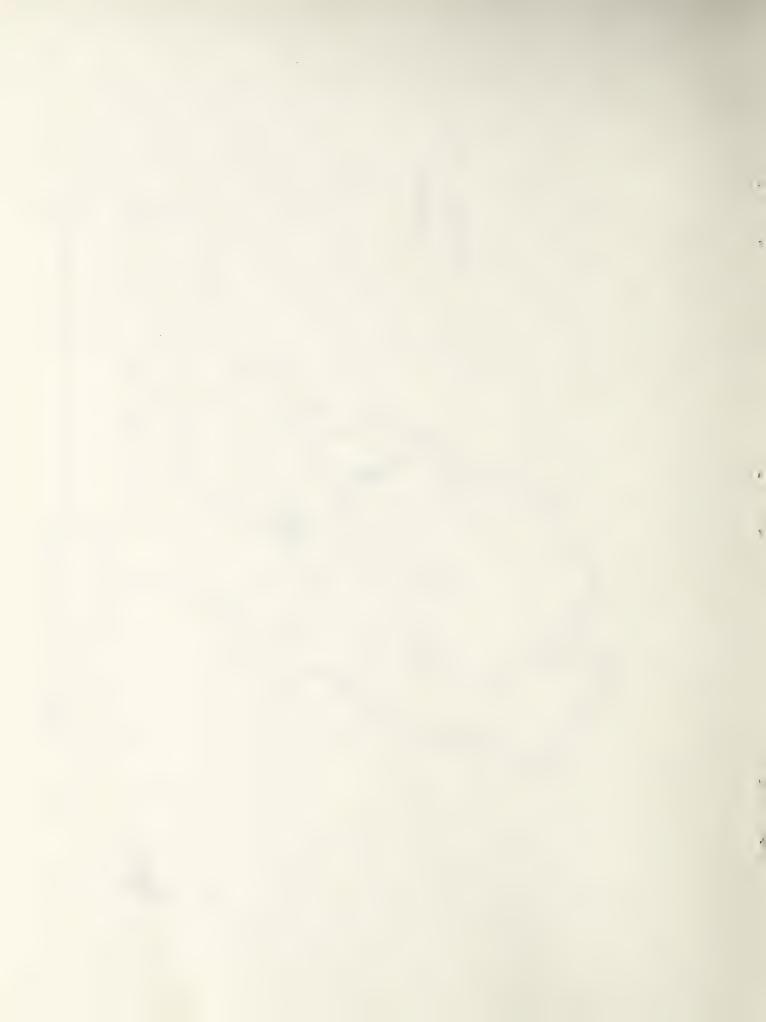
#### Upper Clark Canyon Station

The Upper Clark Canyon station No. 9 is located in the west central portion of Section 6, Township 10S, Range 9W (Figure 4), approximately 75 yards upstream from confluence of Clark Canyon and unnamed creek entering from the northeast. This location is found on the Red Rock, Montana 7.5





Socation of Clark Canyon Creek Sample Basin, Blacktail Planning Unit, Beaverhead County, Montana. Figure 3.



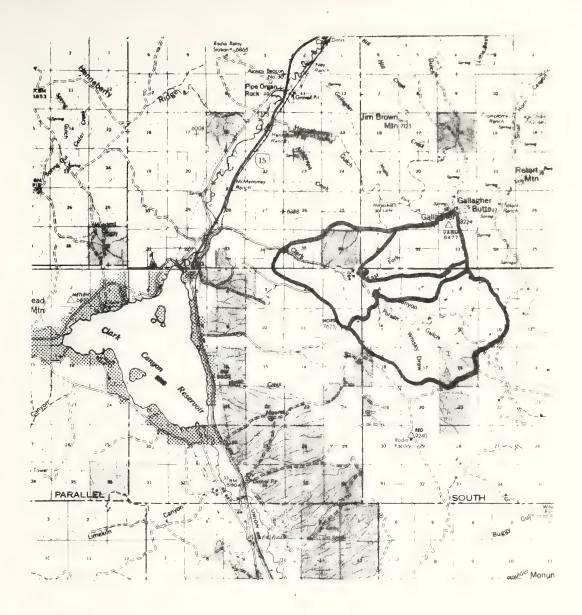


Figure 4. Locations of the Clark Canyon Creek Sampling Stations.



Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 9 on aerial photo No. 4-116-26 of this resource inventory report, and is shown on stream station photo no. 9A. The station is located at 6,320 ft. elevation. The watershed above the station contains approximately 5,400 acres, has a local relief of 2,570 feet, and is oriented to the west-northwest. Approximately 40 percent of the watershed is forested.

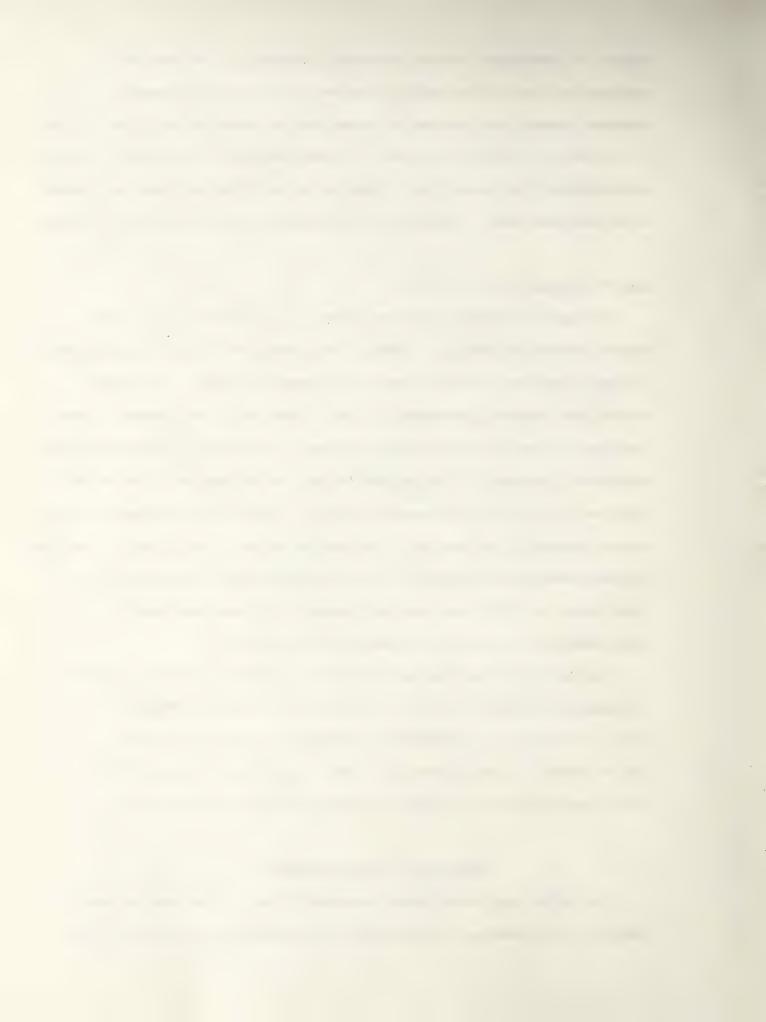
East Fork Clark Canyon Station

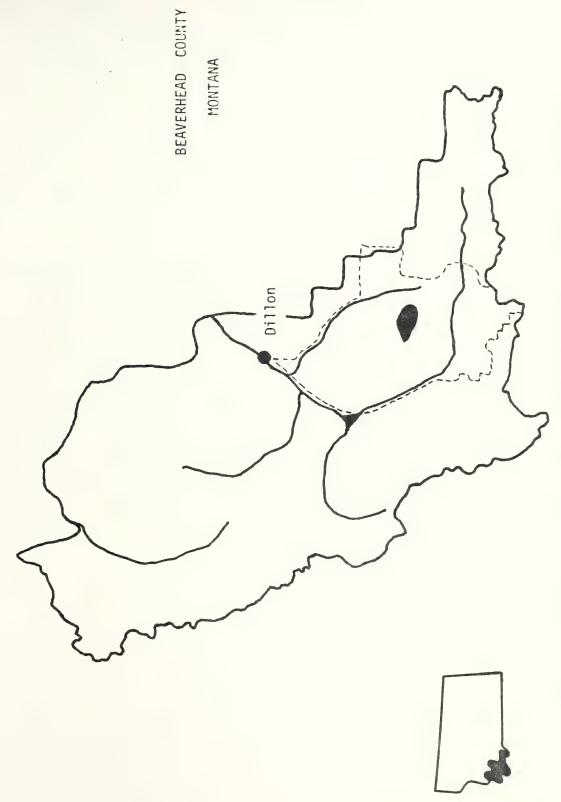
The East Fork Clark Canyon station No. 10 is located in the north western portion of Section 6, Township 10S, Range 9W (Figure 4), approximately 400 yards upstream from where the road crosses the creek. The original station was located approximately 15 yards above the creek crossing. This location is found on the Red Rock, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 10 on aerial photo No. 4-116-26 of this resource inventory report, and is shown on stream station photos no. 10A and 10B. The station is located at 6,200 ft. elevation. The watershed above the station contains approximately 1,700 acres, has a local relief of 2,300 feet, and is oriented to the west-southwest. Approximately 20 percent of the watershed is forested.

The East Fork Clark Canyon precipitation station No. 10G is located in northwestern portion of Section 6, Township 10S, Range 9W (Figure 4). The gage is situated on a low knoll approximately 30 yards upstream and to the left of where the road crosses the creek. The site is depicted as site No. 10G on aerial photo No. 4-116-26 of this resource inventory report.

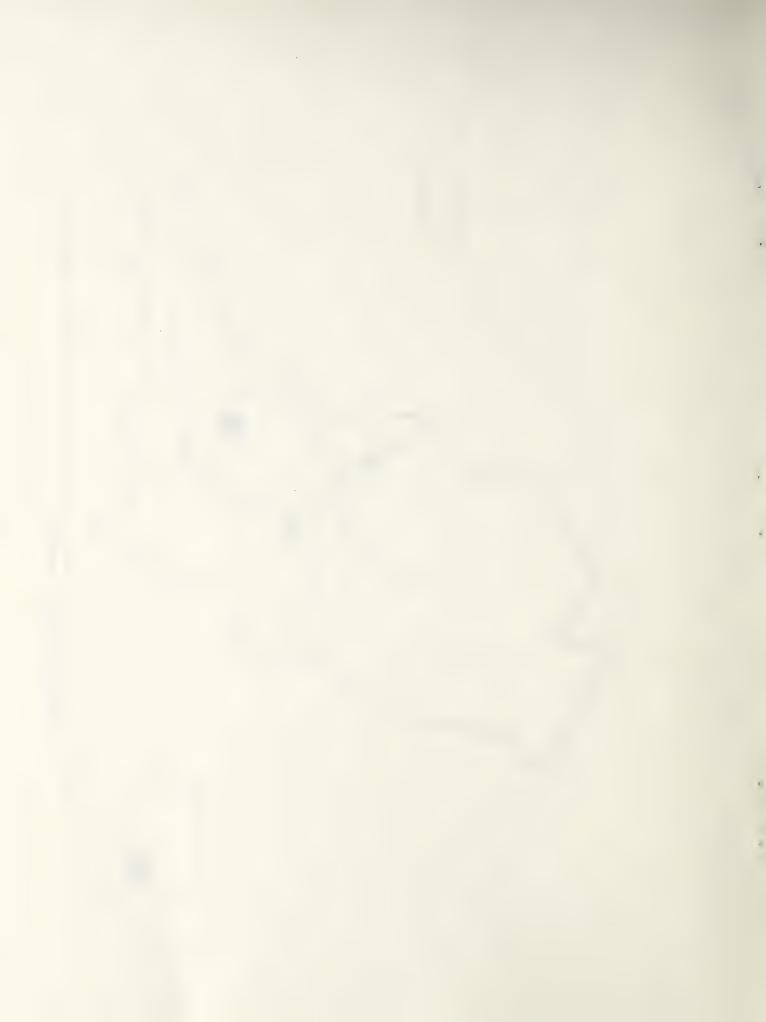
# Little Sage Creek Watershed

The Little Sage Creek sample watershed (Figure 5) encompasses approximately 14,700 acres and includes the Little Sage sampling station. This





Location of Little Sage Creek Sample Basin, Blacktail Planning Unit, Beaverhead County, Montana. Figure 5.



low lying southwest oriented basin ranges from approximately 6,400 feet to 8,500 feet elevation. Its broad open valley, surrounding terraces, and low lying hills are primarily composed of Tertiary sediments, but also include some Tertiary volcanics. The basin is almost completely covered by sagebrush-grassland communities. Mollisols are the dominant soil type. The Bureau of Land Management administers over 65 percent of the basin, 25 percent is in scattered private holdings, and less than 10 percent is State land. Basin use is almost exclusively for grazing.

# Little Sage Creek Station

The Little Sage station No. 12 is located in the southwestern portion of Section 7, Township 12S, Range 7W (Figure 6), approximately 25 yards upstream from where the road crosses the creek. This location is found on the Rock Island Ranch, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 12 on aerial photo No. 14-121-49 of this resource inventory report, and is shown on stream station photos no. 12A and 12B. The station is located at 6,560 ft. elevation. The watershed above the station contains approximately 14,700 acres, has a local relief of 1,950 feet, and is oriented to the southwest. Less than 5 percent of the watershed is forested.

The Little Sage precipitation station No. 12G is located in the south-eastern portion of Section 7, Township 12S, Range 7W (Figure 6). The gage is approximately 75 yards north of the road at a point where the sagebrush-grassland boundary coming down the hill from the south meets the road. The site is depicted as site 12G on aerial photo No. 14-121-51 of this resource inventory report.



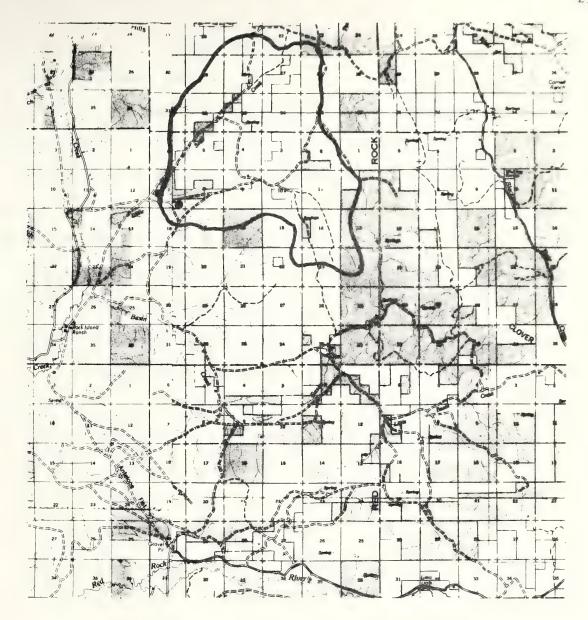


Figure 6. Location of the Little Sage Creek Sampling Station.

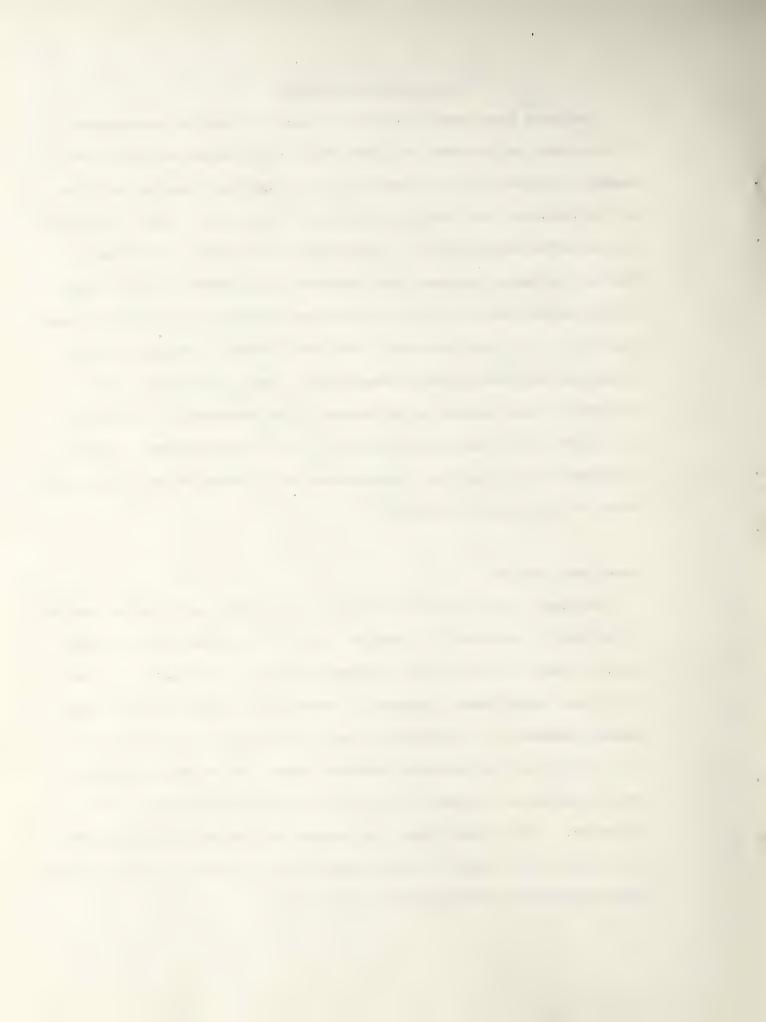


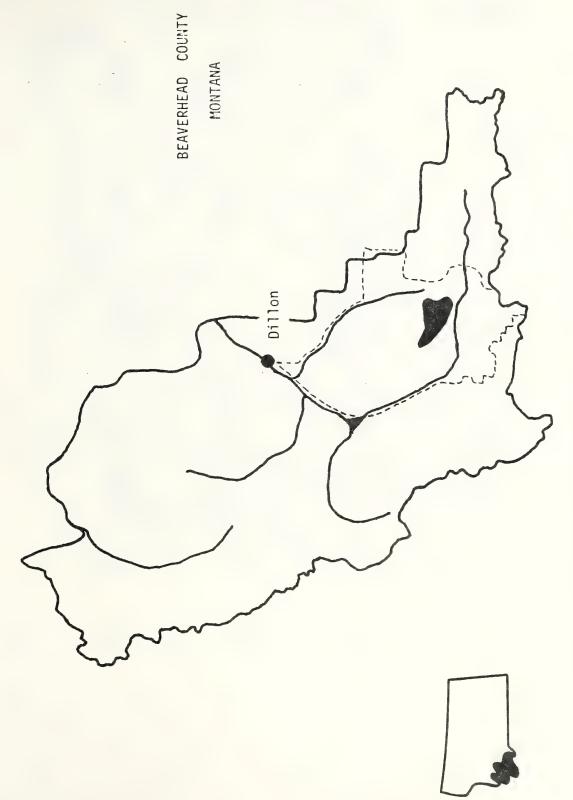
# Basin Creek Watershed

The Basin Creek sample watershed (Figure 7) contains approximately 33,000 acres, and includes the Lower Basin, Upper Basin, and Little Basin sampling stations. This predominantly broad open watershed is encircled by low hills and faces mainly to the west. Local relief ranges from 6,300 feet to 8,700 feet elevation. The geology of the basin is dominated by Tertiary sediments, although some calcareous sedimentary rocks are found in the southeastern portion of the watershed and Tertiary volcanics appear scattered in the lower watershed. Mollisols dominate throughout the area supporting sagebrush-grassland communities. Nearly 60 percent of the watershed is administered by the Bureau of Land Management, 35 percent is State land, while less than 10 percent is in private holdings. The area is almost entirely used for livestock grazing, although large antelope herds winter in the broad open valley.

## Lower Basin Station

The Lower Basin station No. 15 is located in the south central portion of Section 30, Township 12S, Range 7W (Figure 8), approximately 100 yards south of where the road crosses the cattle guard. This location is found on the Rock Island Ranch, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 15 on aerial photo No. 12-122-50 of this resource inventory report, and is shown on stream station photos no. 15A and no. 15B. The station is located at 6,420 ft. elevation. The watershed above the station contains approximately 33,000 acres, has a local relief of 2,300 feet, and is oriented to the west. Less than one percent of the watershed is forested.





Location of Basin Creek Sample Basin, Blacktail Planning Unit, Beaverhead County, Montana. Figure 7.



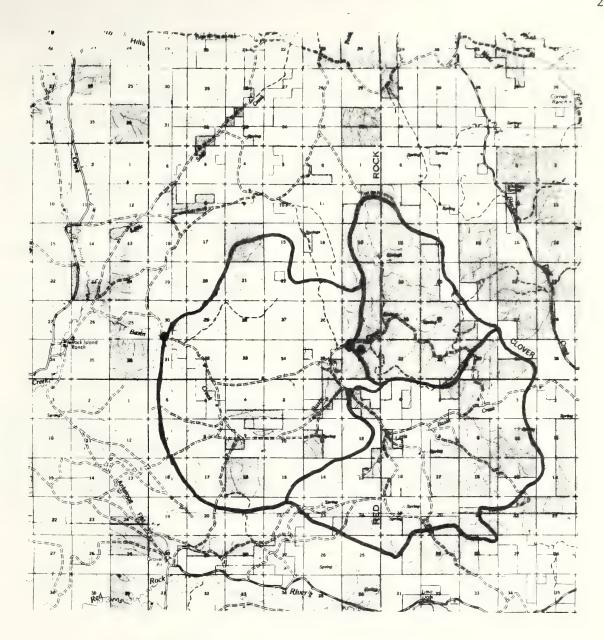


Figure 8. Locations of the Basin Creek Sampling Stations.



## Upper Basin Station

The Upper Basin station No. 13 is located in the northwestern portion of Section 36, Township 12S, Range 7W (Figure 8), approximately 450 yards upstream from the section line. This location is found on the Vinegar Hill Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 13 on aerial photo No. 12-122-52 of this resource inventory report, and is shown on stream station photos no. 13A and no. 13B. The station is located at 6,980 ft. elevation. The watershed above the station contains approximately 6,700 acres, has a local relief of 1,400 feet, and is oriented to the southwest. Less than 5 percent of the watershed is forested.

The Upper Basin precipitation station No. 13G is located in the north-western portion of Section 36, Township 12S, Range 7W (Figure 8). The gage is approximately 75 yards upstream and to the southeast of the stream gaging station No. 13. The site is depicted as site 13G on aerial photo No. 12-122-52 of this resource inventory report.

### Little Basin Station

The Little Basin station No. 14 is located in the northwestern portion of Section 1, Township 13S, Range 7W (Figure 8), approximately 15 yards upstream from the bridge where the road crosses the creek. This location is found on the Henry Gulch, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 14 on aerial photo No. 12-122-52 of this resource inventory report, and is shown on stream station photos no. 14A and 14B. The station is located at 6,860 ft. elevation. The watershed above the station contains approximately 11,800 acres, has a local relief of 1,800 feet, and is oriented to the northwest. Less than one percent of the watershed is forested.



# RESULTS AND DISCUSSION

The results of the water quality survey of the Blacktail, Clark Canyon, Little Sage and Basin Creek sample watersheds of the Blacktail Planning Unit are summarized and briefly discussed below. The basin data for each station is found on the Appendix of this volume.

# Blacktail Creek

The Blacktail Creek sample basin was visited a total of 13 and 13 times during the two hydrologic years. The watershed is closed by the Montana Department of Fish and Game until mid-May. The upper stations were monitored 13 and 12 times respectively each year.

## Channel Stability Ratings

The Lower Blacktail, Upper Blacktail, and Indian Creek stream sections were evaluated on August 15, 1976. The portion of Lower Blacktail Creek between the lower station and the Beaverhead National Forest fence was rated as 'good' (65) (Table 1), approximately a 2.5 mile stream segment above the Forest Service fence was rated as 'fair' (77) (Table 2), and Indian Creek as 'good' (67) (Table 3).

## Precipitation

Precipitation was measured at the Upper Blacktail precipitation station from May 12 through November 12, 1977 and from June 4 through September 15, 1978. The general precipitation patterns during these two fiscal years are compared to those of the Lima and Lakeview weather stations (Figure 9). The Blacktail station received heavy spring and early summer precipitation in 1977, although this pattern is not indicated for 1978.



LOWER BANKS  Landform Slope  Bank slope gradient (307, 1425 Wasting  Caising or Potential  Essentially absent from  (Floatable Objects)  Debtis Jam Potential  Essentially absent from  (Floatable Objects)  Bank Potection  II. LOWER BANKS  Channel Capacity  Channel Capacity  From  From  From  Channel Capacity  From  From  From  From  From  Channel Capacity  From  Fr	S O O O O O O O O O O O O O O O O O O O	Bank slope gradi Infrequent and/o Mostly healed ov future potential Present but most Turgs and limbs.		(6) Bank slope gradient 607, +
dasa Wasting  (Existing or Potential)  (Ebisting or Potential)  (Floatable Objects)  and Protection  (Floatable Objects)  Angetation  Vagetation  LOWER BANKS  hannel Capacity  and Rock Content  Sediment Traps  Sediment Traps  Sediment Traps  Tightness  onsolidation or  Particle Packing  Particle Packing  Onsolidation or  Particle Packing	8	Bank slope gradient 30-40%. Infrequent and/or very small Mostly healed over, Low future potential. Present but mostly small twigs and limbs. 70-90% density, Fewer plant	Bank slope gradient 40-607	***
Wasting (Existing or Potential)  (Existing or Potential)  (Floatable Objects)  ank Protection  Vegetation  LOMER BANKS  LOMER BANKS  hannel Capacity  ank Rock Content  Sediment Traps  Stow Deflectors  Sediment Traps  utting  eposition  BOTTOH  cock Angularity  rightness  onsolidation or  Particle Packing  particle Packing		Infrequent and/or very small Mostly healed over. Low future potential.  Present but mostly small twigs and limbs.  70-90% density, Fewer plant		
Existing or Potential)  bebris Jam Potential  (Floatable Objects)  ank Protection  LOMER BANKS.  LOMER BANKS.  LOMER BANKS.  hannel Capacity  ank Rock Content  Sediment Traps  Sediment Traps  stow Deflectors  Flow Deflectors  Flow Deflectors  rightness  ock Angularity  rightness  orsalidation or  Particle Packing  Particle Packing  Particle Packing	8 00 00 00 00 00 00 00 00 00 00 00 00 00	Mostly healed over, Low future potential. Present but mostly small twigs and limbs. 70-90% density, Fewer plant	Moderate frequency 6 size,	frequent or large, causing
bbis Jam Potential  (Floatable Objects)  ank Protection from Vegetation  LOMER BANKS  hannel Capacity  ank Rock Content  Sediment Traps  Stow Deflectors Sediment Traps  ock Angularity  rightness  onsolidation or Particle Packing	e ar	future potential.  Present but mostly small  twigs and limbs.  70-907 density, Fewer plant	with some raw spots eroded	(9) sediment nearly yearlong OR
Weferential  (Floatable Objects)  Ink Frotection from Veferation  LOWER BANKS  LOWER BANKS  hannel Capacity  batructions  Flow Deflectore Sediment Traps  Sediment Traps  rightness  ock Angularity  rightness  masolidation or Particle Packing Particle Packing Particle Packing Particle Packing Particle Packing	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Present but mostly small twigs and limbs. 70-90% density. Fewer plant	by water during high flows.	-
(Floatable Objects)  ank Protection from Vegetation  LOWER BANKS  hennel Capacity  ank Rock Content  Sediment Traps  Sediment Traps  utting  borrock  BOTTOH  ock Angularity  rightness  masolidation or  Particle Packing  eredian	9 00 00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	plant	Present, volume and size	(6) Moderate to heavy amounts,
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Vegetation  LOWER BANKS  hannel Capacity  ank Rock Content  Flow Deflectore Sediment Traps  eposition  BOTTOM  cock Angularity  rightness  masolidation or Particle Packing Particle Packing	9			<50% density plus fewer
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hannel Capacity  ank Rock Content  Batructions Flow Deflectors Sediment Traps Sediment Traps  rightness ock Angularity  rightness  maouldation or  Particle Packing Particle Packing	9	. до	form a somewhat shallow and	cate poor, discontinuous,
hannel Capacity  ank Rock Content  Flow Deflectore  Sediment Traps  Utting  BOTTOH  ock Angularity  rightness  onsolidation or  Particle Packing  Particle Packing	9	deep root mass.	discontinuous root mass.	and shallow root mass.
hannel Capacity  ank Rock Content  Petructions Flow Deflectore Sediment Traps  utting  eposition  BOTTOM  cock Angularity  rightness  onsolidation or  Particle Packing  Particle Packing  ottom Size Distribution	9			- 1
batructions Flow Deflectors Flow Deflectors Sediment Traps Utting  borting  BOTTOH  ock Angularity  rightness  maolidation or  Particle Packing Particle Packing		to Depth (W/D)	ank	(3) common, W/D ratio >25.
Setructions Flow Deflectore Sediment Traps Utting  POTION OCK Angularity Tightness Onsolidation or Particle Packing Particle Packing			tioods, W/D ratio 15-25.	
Patructions Flow Deflectors Sediment Traps Utting eposition BOTTOH ock Angularity rightness masolidation or Particle Packing	e e	40 to 65%, mostly small boulders to cobble 6-12".	(4) 20 to 40%, with most in the (6) 3-6" diameter class.	(6) < 20% rock fragments of gravel sizes, 1-3" or less.
Flow Deflectore Sediment Traps Utting eposition BOTTOH ock Angularity rightness masolidation or Particle Packing	e	Some present, causing	Moderately frequent, moder-	Frequent obstructions and
Flow Deflectore Sediment Traps  utting eposition BOTIOH ock Angularity rightness onsolidation or Particle Packing Particle Packing otton Size Distribution			ately unstable obstructions	-
Sediment Traps  utting eposition BOTTOH ock Angularity rightness monsolidation or Particle Packing Particle Packing			_	(6) sion yearlong. Sed. traps
eposition  BOTTOM  Ock Angularity  rightness  onsolidation or  Particle Packing  ottom Size Distribution		tions and deflectors newer	Water causing bank cutting	full, channel migration
eposition  BOTION  Ock Angularity  rightness onsolidation or  Particle Packing  otton Size Distribution	ent.	ttently at	Significant, Cuts 12"-24"	Almost continuous cuts.
eposition BOTTOM Ock Angularity rightness onsolidation or Particle Packing ottom Size Distribution	s less (4);			(12) some over 24" high. Fail-
BOTTOM  BOTTOM ock Angularity rightness monsolidation or Particle Packing ottom Size Distribution	ly a	12"	and sloughing evident,	· fure of overhangs frequent.
BOTTOM ock Angularity rightness onsolidation or Particle Packing		ar	"oderate deposition of new	
aorrow ock Angularity rightness onsolidation or Particle Packing ottom Size Distribution	Dars. (4)	formation, most from	gravel & coarse sand on (12	(12) dominately fine particles.
ing fribution				יייייייייייייייייייייייייייייייייייייי
r Ing	3		-punoa	(3) Well rounded in all dimen-
	-		ed in two dimensions.	-
Assorted sizes tight packed and/or overl	ied, or (I)	Mostly dull but may have		(3) Predominately bright, 65% +,
No chance in sizes	(2)	1	(4) Mostly a loose assortment (6)	(6) No packing evident, Loose
No change in sizes	ing.		with no apparent overlap.	475
	evident. (4)	£.	(12) Noderate change in sizes. (12)	-
o recent stable Materials Stable materials 80-1007,	007.	Stable materials 50-80%.	Stable materials 20-507.	Stable materials 0-207.
Scouring and Affected by accuring and	and (6)			(18) in a crate of flux or change in
tton			constrictions and bends	
				8
	_		Present but spotty, mostly	Perennial types scarce or
Ness A Alexan moss like, dark green, per-				(3) absent, Yellow-green, short
COLUMN TOTALS	2 500	here too and swifter waters.	at blooms wake rocks slick.	term bloom may be present.
	. 1			7

Add the values in each column for a total reach score here. (E. \_ + G.65+F. \_ + P. \_ = 65)

Reach score of: <38-Excellent, 39-76-Good, 77-114- Fair, 1154-Poor.

+



t-1 STRE
ec.l
7
Table

USBA-FOREST SERVICE

# STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Upper Blacktail 8/15/76

_	Item Rated			Stability Ind	11cat	Statility Indicators by Classes			
	UPPER BANKS	EXCELLENT	-	0005	(	FAIR	Γ	POOR	
æ11.	Landform Slope		(2) Bank	Bank slope gradient 30-407	3	Bank slope gradient 40-607	9	Bank slope gradient 60% + 15	S
_4	Assa Vant	No evidence of past or	Infr	small,		Moderate frequency & size,			
	(Existing or Potential)	potential for future mass	(3) "Yost	er. Low	Ē	with some raw spots eroded	<u> </u>	sediment nearly yearlong OR /2	Ч
15	Debris Jam Potential	Passon in the sharp from	(2) Pres	Present but mostly seell	*	Present coring night clows.	(4)	Imminert danger or same.	
	(Floatable Objects)	immediate channel area.		twice and limbs.		are both increasing.	9	predominantly larger street	m
-51	Bank Protection	90% + plant density. Vigor	70-9	70-90% density. Fewer plant		50-70% density, Lower vigor		< 50% density plus feuer	
_	from	and variety suggests a	(3) spec	spectes or lover vigor	9	and still fewer species	6	٠.	
	Vegetation	deep, dense root mass.	80 0	suggests a less dense or .		form a somewhat shallow and		-	J
":	LOWER BANKS		need	ucep root mass.	)	discontinuous root mass.		and shallow root mass,	
_		Ample for present plus some	Adeq	Adequate, Overbank flows	=	Barely contains present		Inadequate, Overbank flows	,
¥	Channel Capacity	increases. Peak flows con-	(1) rare	h to Depth (W/D)	9	peaks, Occasional overbank	<u> </u>	common. W/D ratio >25.	4
_		rained, W/D ratio < 7.				floods, W/D ratio 15-25.	_		
	Bank Rock Content	65% + with large, angular boulders 12" + numerous,	(2) 40 t	40 to 65%, mostly small boulders to cobble 6-12".	3	20 to 40%, with most in the 3-6" diameter class.	9	< 207 rock fragments of gravel sizes, 1-3" or less.	$\alpha$
		Rocks, old logs firmly	Some	Some present, causing		Moderately frequent, moder-		80	
	Obstructions	embedded. Flow pattern		erosive cross currents and	-	ately unstable obstructions		deflectors cause bank ero-	C
	ectors	of pool & riffles stable	(2) mino	minor pool filling. Obstruc-	3	& deflectors move with high	9	sion yearlong. Sed. traps 10	$\infty$
	Sediment Traps	without cutting or	tton	tions and deflectors newer	M	water causing bank cutting		full, channel migration	-
		deposition,	pue	and less firm,		and filling of pools,		occuring.	
		Little or none evident.	Some	Some, intermittently at		Significant, Cuts 12"-24"		Almost continuous cuts,	11
~_	Cutting	Infrequent raw banks less	(4) outc	outcurves & constrictions.	8	(8) high. Root mat overhangs	E	some over 24" high. Fail- Va	e.
		than 6" high generally.	Rav	Raw banks may be up to 12".		and sloughing evident,		ure of overhangs frequent,	
		Little or no enlargoment		Some new increas in bar	-	Moderate deposition of new		Extensive deposits of pre- !!	//
	Deposition	of channel or point bars.	(4) form	formation, most from	 @	e .	E	dominately fine particles. Ve	>
֝֝֝֝֝֝֝֝֝֝֝֝֝֝֡֝֝֝֡֝֝֡֝֝֡֝֡֝֡֝֡֡֝֡֝֝֡֡֝֡֡֝֡֡֝֡֡֝֡֡֝֡֡֡֡	ROTTOM		COGL	coarse gravels.		old and some new bars.	3	Accelerated bar development,	
u.		- 1	1/1/10		100	- 1	(		*
-	מבר עופרובול	diana surfaces resolvened	TON (T)	(1) Rounded Corners & edges,	3	(2) Corners & edges well round*	)	Well rounded in all class.	4
I and	Brightness	Surfaces dull, darkened, or	(1) Yost	Mostly dull but may have	(2)	and	6	Predominately bright, 65% +,	Y
_1		stained, Gen, not "bright",	=	up to 35% bright surfaces.	7		)	exposed or scoured surfaces.	-
<u></u>		Assorted sizes tightly	(2) Mode	Moderately packed with	3)	Mostly a loose assortment	9	(6) No packing evident, Loose	o
	7	packed and/or overlapping.	some	some overlapping.		with no apparent overlap.		assortment, easily moved.	>
	Bottom Size Distribution	No change in sizes evident.	(4) Dist	(4) Distribution shift slight.	9	Noderate change in sizes.	(12)	Marked distribution change. //	7
¥X	o rercent stable naterials Stable materials 80-100%,	Stable materials 80-100%	Stab	Stable materials 50-80%.		Stable materials 20-50%.		Stable materials 0-207.	•
		Less than 3% of the borrom	-	<u></u>	- 2	JU-50% affected. Deposits		More than 50% of the bottom	
-	Dense Manage	directed by acouring and	(a) cons	ere	9	a scour at obstructions,	(81)	In a state of flux of change /2	74
	no To Teoday	deposition.	De red	grades steepen, Some		Constrictions, and bends.		nearly yearlong.	
<u>U</u>	Clinging Aquatic	Abundant, Growth largely	Comm	Common. Algal forms in low		Present but spotty, mostly		Perennial types scarce or	-
	Vegetation	moss like, dark green, per-	(1) velo	(1) velocity & pool areas. Moss	3	rin backwater areas. Sesson-	9	(3) absent, Yellow-green, short	+
_	CHOSE & ALKAC	ч.	here	here too and swifter waters,		Al blooms make rocks slick.		term bloom may be present.	
		COLUMN TOTALS	,]	*	2		6		
				4.0	1				

Add the values in each column for a total reach score here. (Z. -+ G. -4F+ F. 29+ F. -- 22.).



1101-Pentit Stawer

Indian Creek 8/15/76

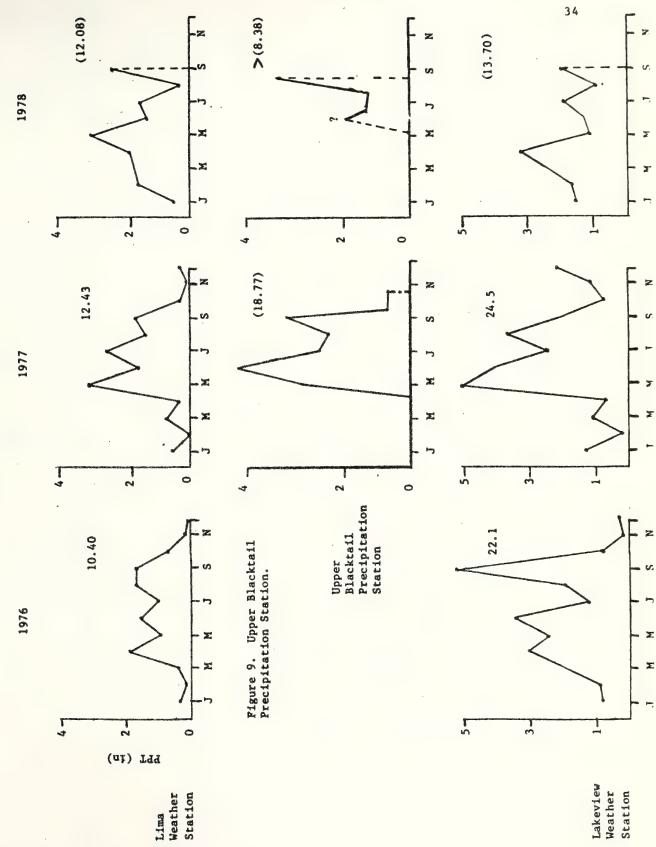
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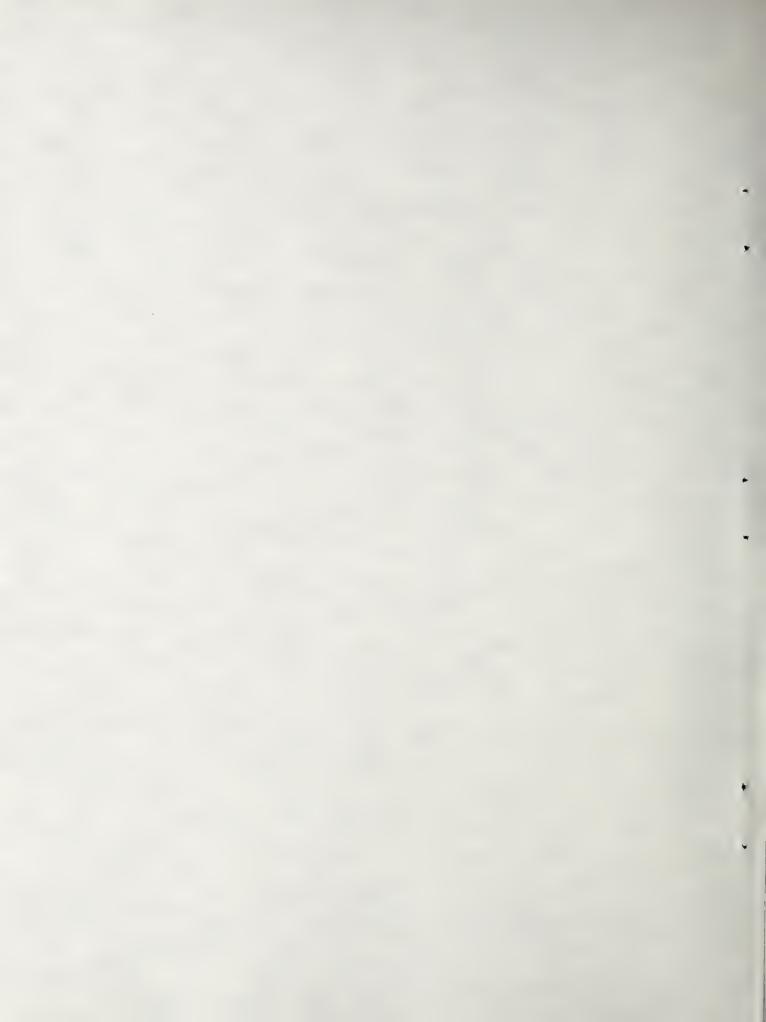
Item Rated		Stacility	/ Tualc	Scacifity Indicators by Classes			
UPPER BANKS	EXCELLENT	0000	'	FAIR		P008	
Landform Slope	Bank slope gradient 4307,	(2) Bank slope gradient 30-40%	( <b>D</b> ), zo	Bank slope g	(9)	Bank slope gradient 60% +	$\boldsymbol{z}$
	No evidence of past or	Infrequent and/or very smal	-	"Moderate frequency & size,		Frequent or large, causing	}
(Felenting on Donners)	potential for future mass	(3) Mostly healed over. Low	<u>e</u>	(6) with some raw spots eroded	6)	sediment nearly yearlong OR	7/
(Existing of forential)	wasting into channels.	future potential.		by water during high flows.		imminent danger of same.	
Debris Jam Potential	Essentially absent from	(2) Present but mostly small	<b>⊕</b>	Present, volume and size	9	Moderate to heavy amounts,	0
(Floatable Objects)	immediate channel area.	twigs and limbs.	-	-=		predominantly larger sizes.	0
Bank Protection	90% + plant density. Vigor	70-90% density. Fewer plant	ant	50-70% density, Lower vigor		<50% density plus fewer	
from	and variety suggests a	(3) species or lower vigor	9	_	6	species & less vigor indi-	1
Vegetation	deep, dense root mass.	suggests a Less dense or	<u>e</u>			cate poor, discontinuous,	,
STATE OF THE PARTY		deep root mass.	7	discontinuous root mass.		and shallow root mass.	_
			-				
Channel Capacity	Increases. Peak flows con-	(1) rare, Width to Depth (W/D)	0) (2)	barely contains present peaks, Occasional overbank	ŝ	Inadequate, Overbank flows common, W/D ratio >25.	4
	tained, W/D ratio <7.	-=		1			_
Bank Bock Costens	65% + with large, angular	(2) 40 to 65%, mostly small	(4)	- =	<u> </u>	< 20% rock fragments of	$\alpha$
ana mora concent	boulders 12" + numerous.	boulders to cobble 6-12"		3-6" diameter class.	3	gravel sizes, 1-3" or less.	7
	Rocks, old logs firmly	Some present, causing		Moderately frequent, moder-		Frequent obstructions and	_
Obstructions	embedded. Flow pattern	-7.	-	-		deflectors cause bank ero-	0
Flow Deflectors	of pool & riffles stable	(2) minor pool filling. Obstruc-	<u>을</u>		<u> </u>	sion yearlong. Sed. traps	ō
Sediment Traps	without cutting or	tions and deflectors newer	La	water causing bank cutting		full, channel migration	
	deposition	and less firm.	+	hand filling of pools.		occuring.	,
4410	Tresoners and beat	Come, intermittently at		Significant, Cuts 12"-24"		Almost continuous cuts,	7
	than 6" high generally.		(2)	and almobito evident	146/	ure of everyance frequent.	
	Little or no enlargement	Some new increas in bar	Γ	₽-		Extensive deposits of pre-	-
Deposition	of channel or point bars.	(4) formation most from	5	pravel 6 coarse sand on	112	dominately fine particles.	%
			છ	old and some new bars.		Accelerated bar development.	-
III. BOTTOM							
Rock Angularity	Sharp edges and corners,	(1) Rounded corners & edges,	-	(2) Corners & edges well round-	┢	(3) Well rounded in all dimen-	4
	plane surfaces roughened.			-	(	sions, surfaces smooth.	
Brightness	Surfaces dull, darkened, or	(1) Mostly dull but may have	(2)	Mixture,	0	Predominately bright, 657. +,	4
	stained, Gen. not "bright",	-		bright, ± 15%, 1e 35-65%.		exposed or scoured surfaces.	-
Consolidation or	Assorted sizes tightly	(2) Moderately packed with	3		3	No packing evident, Loose	0
Particle Packing	packed and/or overlapping.	-	-	with no apparent overlap.		assortment, easily moved.	2
Bottom Size Distribution	No change in sizes evident.	(4) Distribution shift slight.	₹.		(12)	Marked distribution change.	7/
o rercent Stable Materials	o rercent Stable Materials Stable materials 80-1007,	Stable materials 50-80%.	2			Stable materials 0-20%.	١,
		_				More than 50% of the bottom	_
scouring and	affected by scouring and	(6) constrictions and where	3	_	92	in a state of flux or change	124
Deposition	deposition.	grades steepen. Some	2	2794		nearly yearlong.	1
Clearing Accepte	Abres de la company de la comp	deposition in pools	7	-	I		7
Variating Aquatic	Abundant, Growth Largely			Present but spotty, mostly	3	Perennial types scarce or	4
Chose & Alese)	acoutal In end for entry per-	3_	-	(2) In Dackwater areas, Season-	ŝ	(3) absent, rellow-green, short	)
730771 - 7507	COLUMN TOTALS	HELE COO SHO SALLER		A CAUCHA MAKE VOCKE S LICK		Certa proces may be present.	*
	The second second						

Add the values in each column for a total reach score here, (z, 5+6, 45+7, 12+8, 4-62).

Reach score of: <38=Excellent, 39-76 =Good, 77-114= Fair, 1154=Poor.





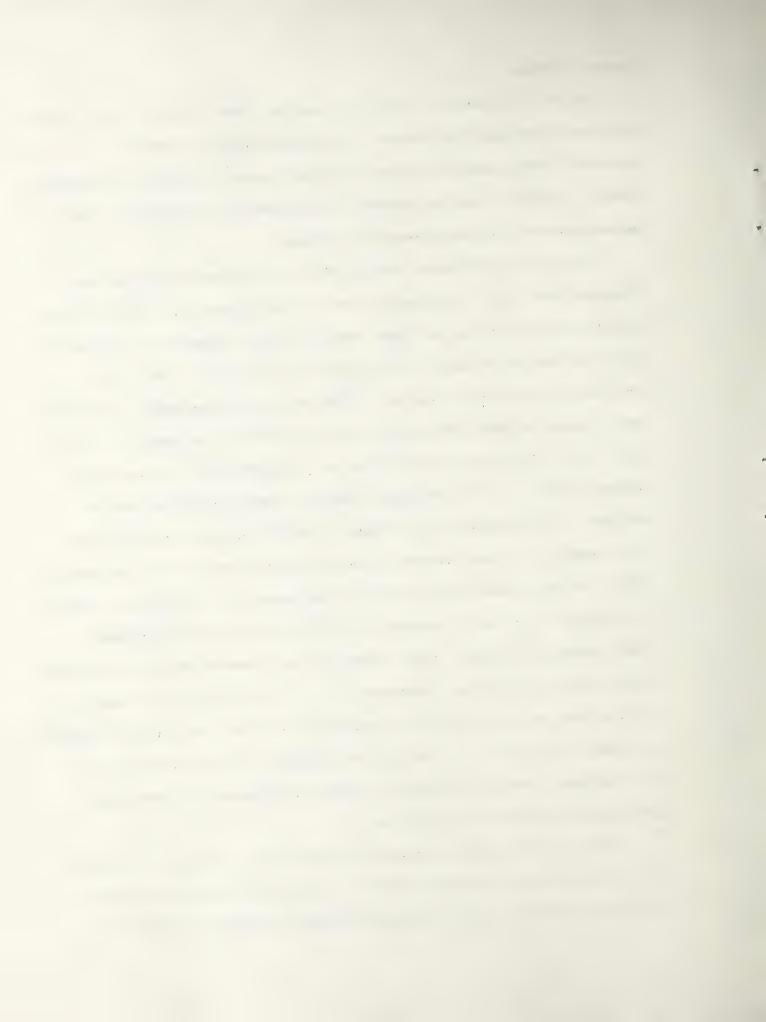


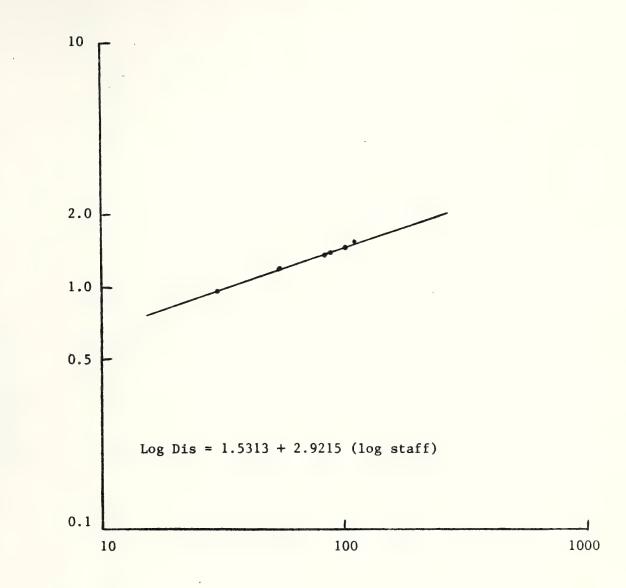
## Stream Discharge

The staff-discharge rating curves for the Lower Blacktail, Upper Blacktail and Indian sampling stations are presented in Figures 10-12. The Blacktail Creek gauging sites remained nearly stable during the two sampling years. The Indian station, however, experienced both sedimentation and modest bank erosion during peak flow periods.

The 1977 and 1978 annual hydrographs for the Lower Blacktail, Upper Blacktail and Indian Creek sampling stations are presented in Figures 13-18. Peak flow during 1977 at the Lower Blacktail station apparently occurred in late June with an estimated crest stage value of 220 cfs. The lowest recorded flow during 1977 was only 18 cfs during late September. The 1978 year produced slightly earlier, but greater peak flow estimated at 430 cfs in early June. The lowest recorded flow for 1978 hydrologic year was 12 cfs during the Fall of 1977. The Upper Blacktail station exhibited similar patterns. An estimated peak discharge of 167 cfs occurred in early June, 1977, however, the lowest recorded flow for the year was 13 cfs in November, 1976. The annual peak flow in 1978 was estimated at 275 in mid-June, while the lowest flow was again recorded at 13 cfs for the previous November. Peak discharge for Indian reek occurred in early June during both hydrologic years, with estimated crest stage values of 5.2 cfs and 7.1 cfs respectively. The low flow period occurred from September - November 1977, when discharge was less than 0.20 cfs. The differences noted in flow patterns for the two hydrologic years are largely attributed to differences in the annual precipitation and snow melt patterns.

The respective annual hydrograph data was used to estimate the annual water yields for each station (Table 4). An estimated 22,700 acre feet and 30,200 acre feet passed the Lower Blacktail discharge sub-station





Staff Gauge (ft.)

Figure 10. Staff-discharge Rating Curve for Lower Blacktail Sampling Station.

Stream Discharge (cfs)



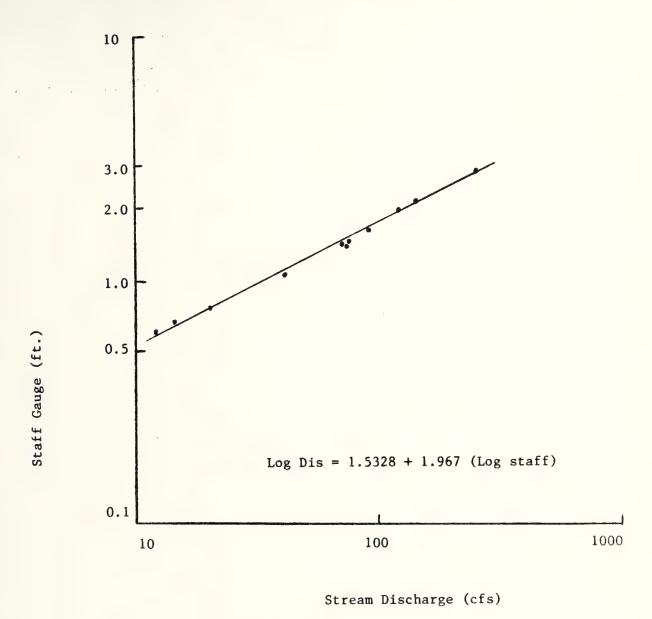
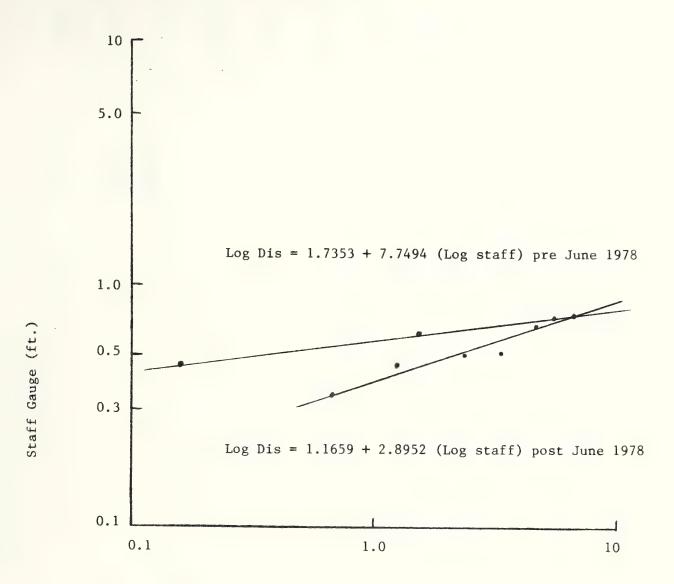


Figure 11. Staff-discharge Rating Curve for Upper Blacktail Sampling Station.





Stream Discharge (cfs)

Figure 12. Staff-discharge Rating Curve for Indian Sampling Station.



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FIGURE 13. ANNUAL HYDROCRAPH AND SEDIMENT LOADINGS



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FIGURE 15. ANNUAL HYDRIGRAPH AND SEDIMENT LOADINGS



PIGURE 16. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

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FIGURE 17. ANNUAL HYDRIGRAPH AND SEDIMENT LOADINGS

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450.0000 20.0000 0.0000 500.0000 350.0000 300.0000 200.000 250.0000 150.0000 100.000 400.000 SEP 30 AUG : JUN : FIGURE 18. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS : APR INDIAN - 1978 FEB DEC OCT 1 \*+~0000.0 +rara\*6 3.0000+ 10.000.01 7.0000 \*\*\*\*\*\*\*\*\*\*\* €. ₽066A+ 2.000.4 ۥدورد 4.000. 1.0.0.1 



Estimated Water and Sediment Yields for the Blacktail Sample Basin, 1977-1978. Table 4

Station Name.	Water Year	Estimated Water Yield (ac ft.)	Estimated Sediment Yield (tons)	Contributing Watershed (acres)	Runoff (in./ ac.)	Sediment Yield (lbs/acre)
Lower Blacktail Station(s)	1977	22,700	1,180	29,150 18,560	9.34	127
	1978	30,200	5,360	29,150 18,560	12.4	578
Upper Blacktail	1977	16,100	820	13,890	13.9	118
1011210	1978	24,200	3,430	13,890	20.9	493
Indian Station	1977	260	31	1,090	6.21	56.3
	1978	610	75	1,090	6.68	137



during 1977 and 1978. The Upper Blacktail averaged approximately 75 percent of the lower station's yields. Indian Creek generated annual yields of 560 and 610 acre feet respectively. Each station indicated greater discharges during 1978, although differences for Indian Creek may be underestimated owing to channel changes at the station site.

### Suspended Sediment

The annual pattern of sediment concentration for each station by hydrologic year is depicted in Figures 13-18. Suspended sediment concentrations at the Lower Blacktail water quality sub-station ranged from (5 ppm at low flow to 670 ppm at high flow, those for the Upper station ranged from <5 ppm to 585 ppm, and from <5 ppm to 480 ppm for the Indian station. Higher suspended sediment values were recorded during the 1978 hydrologic year when there were higher discharge values. The relationships between suspended sediment and stream discharge for the Blacktail and Indian stations were statistically significant, and are presented in Figures 19-21. The variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effects, and to the hysteresis effect, whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973, pp. 215-219). Annual sediment yields for the sample stations were estimated from respective water yield and sediment concentration data (Table 4). Sediment yield data for the Lower Blacktail station were generated from suspended sediment concentration data obtained at the water quality sub-station No. 8A, but using water yield data from the discharge monitoring sub-station No. 8B. The Lower and Upper stations produced approximately 1,180 tons and 820 tons of suspended sediment respectively during 1977. These yields increased to 5,360 tons and 3,430 tons for the more active 1978 hydrologic year. Sediment



STREAM DISCHARGE :CFS:

FIGURE 19, SUSPENDED SEDIMENT VS STREAM DISCHARGE - LOWER BLACKTAIL

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FIGURE 21. SUSPENDED SEDIMENT VS STREAM DISCHARGE - INDIAN ...

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6	0.158	0.251 0	0.398 0.631 STREAM D	0.631 1.000 STREAM DISCHARGE :CES:	1.585 2.512	3.981	6.310 1	10.030

STREAM DISCHARGE :CFS:



yields for the Indian station were 31 tons and 75 tons.

# Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lower concentration occur during periods of high runoff, while higher concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Walling, 1973, pp. 219-225). Patterns for specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et. al., 1977,pp. 74-76).

Specific conductance for the Lower Blacktail station ranged from a low of 208 µmhos during high spring runoff to a high of 363 µmhos during late summer base flow. The Upper Blacktail station exhibited a similar pattern, values ranging from 190 µmhos to a high of 357 µmhos. Indian Creek experienced greater range in conductivity including values from 282 to 462 umhos. The relationships between specific conductance and stream discharge for each station were statistically significant and are presented in Figures 22-24. Variation in specific conductance with stream discharge is partially attributed to seasonal and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225). The ranges in ionic concentration for specific ions are presented in Table 5.

#### Bacteria Levels

The concentration of fecal and total coliform in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising stage (Kunkle and



FIGURE 22, CONDUCTIVITY VS STREAM DISCHARGE - LOWER BLACKTAIL

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13.000	15.849	25,119	39,811	63.096	109.090	158,489	251-189	398.107	136.063	1000.001



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UPPER BLACKTAIL
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CONDUCTIVITY VS
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FIGURE 24. CONDUCTIVITY VS STREAM DISCHARGE - INDIAN

LOG COND = 2.5791 - 0.6569(LOG DIS)

 $\Box$ 



Table 5 Hydrochemical Characteristics of the Blacktail Watershed Sampling Stations, 1977-1978.

		Upper Blacktail	Indian
pН	7.95 - 8.28	7.76 - 8.23	7.95 - 8.30
Alkalinity (CaCO <sub>3</sub> ) (mg/1)	130 - 165	121 - 178	142 - 178
Specific Conductance (µmhos) Total Dissolved Solids (mg/l)	208 - 363 135 - 235	190 - 357 124 - 232	282 - 462 183 - 300
Ca (mg/1) Mg (mg/1) Na (mg/1) K (mg/1) HCO <sub>3</sub> (mg/1) SO <sub>4</sub>		7.8 - 15 2.7 - 5.0	1.3 - 2.6 .60 - 1.0
NH (mg/1) NO <sub>2</sub> + NO <sub>3</sub> - N (mg/1) PO <sub>4</sub> (Ortho) -P (mg/1)	<.0114 <.0117 T055	<ul><li>&lt;.01 - (.44)</li><li>.0215</li><li>.002048</li></ul>	.0231



Meiman, 1968), with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their own "flushing" effect, and which may or may not be followed by a short term dilution period.

The concentrations of fecal coliform for the Blacktail basin sampling stations for the study period are presented in Table 6. Higher values occurred during the grazing season, especially during 1977 when there were higher livestock concentrations. Maximum fecal coliform levels were 50, 4, and 23 colonies/100 mls respectively for each station. None of the sample coliform counts exceeded the 200 colony/ 100 ml limit of the Montana Water Quality Criteria. The lowest values were associated with the spring and fall seasons.

#### Comments

The Blacktail Creek basin sustains a high spring discharge owing to its mountainous upland watershed. High water yields contribute to naturally high sediment yields. Cattle use was moderate during the study period.

Because of the limited number of samples and the nature of the hydrochemical parameters selected for evaluation, relationships between the water quality characteristics of Blacktail and Indian creeks and the Montana Water Quality Criteria cannot be addressed.



Table 6 Fecal Coliform Counts (colonies/100 mls) for the Blacktail Watershed Sampling Stations, 1977 - 1978.

	Low Black		-	per ktail	Inc	dian
	1977	1978	1977	1978	1977	1978
April						
May	<b>&lt;</b> 1	2	< 1	< 1	< 2	∠1
June	1	< 2	1	3	< 1	<1
July	51*	<1	3	3	<b>~1</b> *	<1
August	40*	27*	2	<b>∠</b> 1*	23*	2*
September	8	3*	4	1*	<b>~</b> 2	4*
October	4		< 4		∠ 2	
November	2		1		<b>&lt;</b> 2	

<sup>\*</sup> Stock visually present

<sup>(?)</sup> Stock presence uncertain



## Clark Canyon Creek Basin

The Clark Canyon Creek sample basin was visited a total of 16 and 18 times during the two hydrologic years. The Upper Clark Canyon and East Fork stations were monitored 15 and 18 times respectively. Sampling problems were confined to the East Fork where residual ice, flash flooding, channel alteration, and irrigation diversion were intermittently common. The East Fork station was moved after the 1977 hydrologic year, but channel instability again precluded generating a valid staff-discharge rating curve. Instant discharge readings are primarily those directly taken in the field. No crest stage readings were obtained. Flash flooding often left the thermometer housing perched out of the water.

# Channel Stability Ratings

The Lower Clark Canyon, Upper Clark Canyon, and East Fork Clark Canyon stream segments were evaluated on August 13, 1976. The portion of Clark Canyon Creek from the Lower station to the confluence with the East Fork was rated as 'fair' (99) Table 7). The Upper Clark Canyon segment extended upstream from the East Fork for approximately 2 1/2 miles and was rated as 'fair' (109) (Table 8). The East Fork Clark Canyon was ranked 'fair' with a score of (97) (Table 9). The latter rating may be currently underestimated.

### Precipitation

Precipitation was measured at the East Fork Clark Canyon precipitation station from April 21 through November 10, 1977 and from April 5 to September 13, 1978. The general precipitation patterns during these two fiscal years are compared to those of the Dillon and Lima weather stations (Figure 25). Precipitation peaks are shown for May and September of each



USBA-POREST SERVICE

TICH VEICO		Stability In	Stability Indicators by Classes	
I. UPPER BANKS	EXCELLENT	COOD	FAIR	POOR
Landform Slope	Bank slope gradient <30%	(2) Bank slope gradient 30-40%	ent 40-60%	(6) Bank slope gradient 60% + 18
	No evidence of past or	Infrequent and/or very small	Moderate frequency & size,	sent or large, causing
(Existing or Potential)	potential for future mass	(3) Mostly healed over. Low	(6) with some raw spots eroded	sediment nearly yearlong OR /2
Debris Jam Potential	Essentially absent from	(2) Present but mostly small		Moderate to beavy agouste.
(Floatable Objects)		twigs and 11mbs.		Spredominantly larger sizes.
Bank Protection	90% + plant density, Vigor	70-90% density. Fewer plant	50-70% density. Lower vigor	< 50% density plus fewer
from	and variety suggests a	(3) species or lower vigor	_	(9) species 6 less vigor indi-
Vegetation	deep, dense root mass.	suggests a less dense or	pue	Cate poor, discontinuous,
II. LOWER BANKS		Tool mass.	Targettungs too mass.	4-
Channel Capacity	Ample for present plus some increases. Peak flows con-	(1) rare, Width to Depth (W/D)	ank	Inadequate, Overbank flows 4
Bank Rock Content	65% + with large, angular	(2) 40 to 65% mostly small houlders to cobble 6=12"	(4) 20 to 40%, with most in the	< 20% rock fragments of
	Rocks, old logs firmly	Some present, causing	Moderate V frequent, moder-	Frequent obstructions and
Obstructions	embedded, Flow pattern	-	ately unstable obstructions	deflectors cause bank ero-
Flow Deflectors	of pool & riffles stable	(2) minor pool filling. Obstruc-	(4) & deflectors move with high	(6) Sion yearlong. Sed. trape ()
adear mammac	deposition	and Less firm.	and filling of pools.	occuring.
	Little or none evident.	Some, intermittently at	Significant, Cuts 12"-24"	
Bullana	Intrequent raw banks less	(4) outcurves & constrictions.	(8) high. Root mat overhangs [1	(12) some over 24" high, Fail-
	Little or no enlargement	Some new increas in bar	f new	Extensive deposits of pre-
Deposition	of channel or point bars.	(4) formation, most from	(8) gravel & coarse sand on	(12) dominately fine particles. Ve
III. BOTTON				100
Rock Angularity	Sharp edges and corners,	(1) Rounded corners & edges,	(2) Corners & edges well round-	Well rounded in all dimen- 4
Brightness	Surfaces dull, darkened, or	(1) Mostly dull but may have		(3) Predominately bright, 657. +, A
0	stained, Gen, not "bright",	up to 35% bright surfaces.	bright, ± 15%, 1e 35-65%.	exposed or scoured surfaces.
Consolidation of	Assorted sizes tightly	(2) Moderately packed with	_ >	No packing evident, Loose
Bottom Size Distribution	No chance in sizes outdone	(2) Dierriburion of for aliche	(8) Volerate change in size	Warted distriction chanse
6 Percent Stable Materials	6 Percent Stable Materials Stable materials 80-100%,	_	Stable materials 20-50%.	70) Stable materials 0-207.
	Less than 5% of the bottom	-		Hore than 50% of the bottom
Scouring and	affected by scouring and	(6) constrictions and where	and .	[18] in a state of flux or change 24
Deposition	deposition.	grades steepen. Some deposition in pools.	Some filling of pools.	son nearly yearlong.
Clinging Aquatic	Abundant, Growth largely	Common, Algal forms in low	Present but spotty, mostly	Perennial types scarce or
Moss & Algae	moss like, dark green, per-	(1) welocity 6 pool areas. Moss	(2) in backwater areas. Season-	(3) absent. Yellow-green, short
	A		6	- 13
		2001.00		}

Add the values in each column for a total reach score here. (E. \_ + G. 9 + 7.27 + P. 13 = 99).



Table 8

Upper Clark Canyon 8/13/76

Item Rated		Stability Ind	Stability Indicators by Classes	
UPPER BANKS	EXCELLENT	0000	EALR	POOR
Landform Slope	Bank slope gradient <30%	(2) Bank slope gradient 30-407	(4) Bank slope gradient 40-607, (6)	Bank slope g
	No evidence of past or		†-	Frequent or large, causing
(Existing or Potential)	potential for future mass	er. Low	(6) with some raw spots eroded	
Debris Jan Potential	The coorse all a she can recom	(2) Promote hit mostly	5	Imminent danger of same.
(Floatable Objects)	immediate channel area.		lare both increasing.	oredominantly larger sizes
Bank Protection	90% + plant density. Vigor	70-90% density. Fewer plant	r vigor	-
from			(6) and still fewer species ((9)	-
Vegetation	deep, dense root mass.	suggests a less dense or	form a somewhat shallow and	
II. LOWER BANKS		deep root mass.	discontinuous root mass.	and shallow root mass.
	Ample for present plus some	Adequate, Overbank flows	Barely contains present	Inadequate, Overbank flows
Channel Capacity	increases. Peak flows con-	(1) rare. Width to Depth (W/D)	(2) peaks. Occasional overbank (3)	3) common, W/D ratio >25. 4
	165% + with larve, appular	mostly small	(4) 20 to 407 with most in the (6)	C20% rock fragments of
Bank Rock Content	boulders 12" + numerous.	boulders to cobble 6-12"	[3-6" digneter class.	-
	Rocks, old logs firmly	Some present, causing	Moderately frequent, moder-	Frequent obstructions and
Obstructions	embedded. Flow pattern	erosive cross currents and	ately unstable obstructions	deflectors cause bank ero-
Flow Deflectors	of pool & rifiles stable	10	(4) & deflectors move with high (6)	_
Sediment Traps	Without cutting or	tions and deflectors newer	water causing bank cutting	nne! migration
	Little or none evident.	Some intermittently at	Significant, Cuts 12"-24"	Almost continuous cuts.
Cutting	Infrequent raw banks less	us.	(8) high. Root mat overhangs (12)	
	"than 6" high generally,	Raw banks may be up to 12".	and sloughing evident.	' Jure of overhangs frequent,
	Little or no enlargement	Some new increas in bar		Extensive deposits of pre-
Deposition	of channel or point bars.	(4) formation, most from	(8) gravel & coarse sand on (12)	2) dominately fine particles.
BOTTOM				
Rock Angularity	Sharp edges and corners,		-punor	Well rounded in all dimen- 4
D - 4 - 1 - 4 - 5 - 5	plane surfaces roughened.	_	ed in two dimensions.	sions, surfaces smooth.
e reintiese	straces duil, darkened, or stained, Cen. not "bright".	up to 35% bright surfaces.	(2) Mixture, 50-50% dull and 51 bright, ± 15%, 1e 35-65%.	exposed or scoured surfaces.
Consolidation or	Assorted sizes tightly		(4) Mostly a loose assortment ((6)	k- 1
Particle Packing	packed and/or overlapping.	some overlapping.	=-1	
Bottom Size Distribution	No change in sizes evident.	ا‡،	(8) Noderate change in sizes. (12)	Marked distribution change.
recent Stable Materials	recent Stable Materials Stable materials 80-100%.	Stable materials 50-80%.	Stable materials 20-50%.	Stable materials 0-20%.
		5-30% affected, Scour at	JU-50% affected, Deposits	
Scouring and	sirected by scouring and	re	12) a scour at obstructions, (18)	
Deposit Crod	deposition.	grades ateepen. Some	Some filling of pools.	nearly yearlong.
Clinging Aquatic	Abundant, Growth largely	Comon, Algal forms in low	Present but spotty, mostly	Perennial types scarce or
Vegetation (Moss & Algae)	moss like, dark green, per-	(1) velocity 6 pool areas. Moss	,	יו
	4		70-10	05
	1	]		ני

Add the values in each column for a total reach score here. (E. \_ + G. (4 + P. 45 + P. 50 - 109).

Reach score of: (38=Excellent, 39-76 "Good, 77-114" Fair, 1154=Poor.



East Fork Clark Canyon 8/13/76

The state of the s	R BANKS						
Bank stope Relation (2007) (2) Bank stope Relation (2007) (4) Bank stope Relation (2007) (5) Bank stope Relation (2) Bank stope (2) Bank stope Relation (2) Bank stope (2) Bank s		EXCELLENT	0000	FAIR		POOR	ı
More than 1   Moder to the state of the st	Slope	Bank slope gradient <30%		Bank slope gradient	٢	Bank slope g	2
potential) potential for future mass (1) "Stoatly hasled over. Low (5) by water during high flow. At the control of the contro	4	No evidence of past or	Infrequent and/or very small	"Moderate frequency & siz		Frequent or large, causing	
Essentially absent from   (2) Present but mostly small   (6) Present, volume and size   (7)	ng or Potential)	potential for future mass	(3) Mostly healed over. Low			-	7
1000   1000	am Potential	Essentially absent from	7	-	T	-	T
and variety suggests a less dense or discontinuous root mass.    Ample for present plus some   Adequate, Overbank flows   Grome a somewhat shallow and deep root mass.   Growthank flows   Growthan	table Objects)	immediate channel area.	-	lare both increasing.	<u>ن</u>		$\alpha$
and variety suggests a greate or lover vigor (6) and still fewer species (2) species a less dense or discontinuous roof mass.  Ample for present plus same (Adequate. Overbank flows) (10 mass of the casional overbank (3) finitesase. Peak flows con- (1) fare. Width to Depth (W/D) (2) peaks, Occasional overbank (3) finitesase. Peak flows con- (2) fate, 915.  The boulders lift any angular (3) for to 65%, mostly small (2) to to 40%, vict most in the (6) food of it files a majure (3) for to 65%, mostly small (3) for the flows transple to structions of pool 6 it files a table (3) for the flows currents and attely unsable to structions of pool 6 it files a table (3) for the flows and deflectors never (3) and flows cutting of and the flows flows the flows and deflectors never (4) deflectors move with high (6) flows and deflectors never (5) and flows flows the flows flows the flows flows and less flows. Constructions (3) flows flows the flows flows and deflectors never (4) flows flows the flows flows and less flows the flows f	tection	190% + plant density, Vigor	70-90% density. Fever plant	50-70% density, Lower vi		diam'r.	1
deep, dense root mass.    Juggests a less dense or	E	and variety suggests a			_	-	- 1
Ample for present plus some (1) rate, Width to Dapth (W/D) (2) peaks, Occasional loverbank (3) tained, W/D ratio (3)—2.  Taine Strate, and the practic of the peaks, Occasional loverbank (3) tained, W/D ratio (3)—2.  Taine Strate, and the practic of the peaks, Occasional loverbank (3) tained to boulders it could to boulders to cobble 6-12" (3)—6. "disreter class.  Rocks, old logs firmly boulders to cobble 6-12" (3)—6. "disreter class.  Rocks, old logs firmly boulders to cobble 6-12" (4) tained to boulders to cobble 6-12" (5)—6. "disreter class.  Rocks, old logs firmly boulders to cobble 6-12" (5)—6. "disreter class.  Rocks, old logs firmly boulders to cobble 6-12" (5)—6. "disreter class.  Rocks, old logs firmly boulders to cobble 6-12" (5)—6. "disreter class.  Traps of pool 6 rifits stable (2) minor pool filling, Observe (4) tained pools.  Little or none evident.  Some, intermittently at and filling observe.  Little or none evident.  Some, intermittently at Significant, Cuts 12"-24" (1) intermittently at the pools.  Little or no calayoned.  Some new increas in bar (8) high. Rock mat overlangs than 6 the pools.  Little or no calayoned.  Some new increas in bar (8) high. Rock mat overlangs.  Little or no calayoned.  Some new increas in bar (8) high. Rock mat overlangs.  Command or point bars.  (4) formation, most from.  Some overlapping.  Stained, Gen. not. "Some new increas in bar (9) right, a 13", a 13-5-57", a	tion	deep, dense root mass.	suggests a less dense or	form a somewhat shallow			
Ample for present plus some Adequate. Overbank flows (peaks, Coccasional overbank (3) [Eigods, 3/D ratio 51-5.]  Egined, WD ratio 7.  Egined, WD ratio 51.  Egined, Egined Frequent, Egines and deflectors never (3) safeticate classing bank cutting clool 6. Iffiles stable (1) inimor pool 1 [Illing, Obstruct. (3) safeticate and cutting of pool 6. Iffiles stable (2) inimor pool 1 [Illing, Obstruct. (3) safeticate deposition.  Electron one evident.  Electr	RANKS		deep root mass.	discontinuous root mass.	1	and shallow root mass.	٦
tincreases. Peak flows con- (1) rare, Width to Depth (W/D) (Peaks, Occasional overbank (1))  teained, Width targe, angular (2) do to 65%, mostly small (C 20 to dof), with most in the (6)  boulders 12" + numerous. (2) do to 65%, mostly small (C 20 to dof), with most in the (6)  Rocks, old logs firmly stream (2) and to 65% and the factors are cross currents and actors unstable obstructions of pool & Liffles stable (2) minor pool filling, Obstruc- (4) & deflectors move with high (6)  traps of pool & Liffles stable (2) minor pool filling, Obstruc- (4) & deflectors move with high (6)  Little or none evident, Some intermittently at deposition of mery and less firm. (4) gravel & coarse sand on coarse gravels. (5) firm most firmly most firmly stable (6) high scenerally. (5) formation, most from (6) gravel & coarse sand on coarse gravels. (7) gravel & coarse sand on coarse gravels. (7) firmly coarse gravels. (8) firstly and some new bars. (7) firmly coarse gravels. (8) firstly and some new bars. (9) gravel & coarse gravels. (1) Rounded corners & edges, (1) Corners & edges well round- (3) gravel & coarse gravels. (4) firstly surfaces and or point bars. (4) Rounded corners & edges, (5) Corners & edges well round- (3) Surfaces dull, darkened, surfaces gravels. (4) Misth surfaces and or point bars. (4) Mostruction work firmly stable and or corners, (4) Mostruction work firmly stable, and or corners gravels. (5) Mostructions or coarse gravels. (6) Mostruction or coarse gravels. (7) Mostruction stable materials 50-50% dull stable materials 50-50% dull stable materials 50-50%. (7) Mostructions, gravel & coarse gravels. (7) Mostructions, gravel & coarse gravels. (8) Mostructions, gravel & coarse gravels. (7) Mostructions, gravel & coarse deges well rounded corners & coarse carried begos stable materials 50-50%. (8) Mostructions, gravel & coarse deges well rounded corners & coarse carried begos well to coarse gravels. (6) Mostructions, gravel & coarse deges well rounded corners & coarse carried begos well to coarse gravels. (6)		Ample for present plus some	Adequate, Overbank flows	Barely contains prescut	-	Inadequate, Overhank flow	١
tesined, WD ratio 67,  tesined, WD ratio 127,  tesined 62, 4 of large angular (2) tesine cobbit 6-12",  tespes of logs firmly corrected cost currents and testy unstable obstructions of pool 6 rifiles stable (111ing, Obstruc- (4) deflectors move with high (6) titons and deflectors newer (5) deflectors move with high (6) trions and deflectors newer (7) ager causing bank cuting caposition.  Traps of pool 6 rifiles stable (111ing, Obstruc- (5) deflectors move with high (6) trions and deflectors newer (7) ager causing bank cuting caposition.  Third or none evident.  Third or none evident.  Third or none evident.  Third or none and symmet.  Third or none and or none and symmet.  Third or none and or none and symmet.  Third or none and	Capacity	increases. Peak flows con-	rare, Width to Depth (W/D)	** .		_	4
Control   Cont			ratio 8-15.				
Some present, causing   3-6" diameter class.	ok Contant	65% + with large, angular	-			-	$\alpha$
Rocks, old logs firmly Gome present, causing atcelusately frequent, moderate or post filling. Obstance of pool & crifiles stable (2) minor pool filling. Obstance of pool & crifiles stable (2) minor pool filling. Obstance of pool & crifiles stable (2) minor pool filling. Obstance of pool & crifiles or cuting or tions and deflectors newer of water causing bank cutting and less firm.  Little or none evident.  Little or no maryoner.  Little or no charyoner.  Little or no charyoner.  Little or no charyoner.  Little or no charyoner.  Control of channel or point bars.  (4) Some new increas in bar and sloughing evident.  Little or no charyoner.  Control of channel or point bars.  (5) Rounded corners & edges, cold and some new bars.  Control of channel or point bars.  (6) Rounded corners & edges, cold and some new bars.  Control of channel or point bars.  (7) Rounded corners & edges, cold and some new bars.  Sharp edges and corners.  (8) Riskle of and some new bars.  Control of c	כע רסטנפטנ	"boulders 12" + numerous.	boulders to cobble 6-12",			gravel sizes, 1-3" or less	
of pool & richias stable (2) minor pool filling. Obstruct (4) & deflectors move uttin high (6) fitness and deflectors never (2) water causing bank cutting and deflectors never (3) water causing bank cutting and obstructions and deflectors never (4) & deflectors move utting of pools.  Little or none evident.  Significant. Cuts 12'-2"  Infrequent raw banks less (5) Outcures constrictions. (6) high. Root mat overhangs than 6" high generally.  Eav banks may be up to 12".  Little or non enlargement (4) formation, may be up to 12".  Correct and sloughing evident.  Correct gravels. (6) Fav banks may be up to 12".  Sharp edges and corners, (7) Rounded corners 6 edges, (8) Fight and some nev bars.  Sharp edges and corners, (1) Rounded corners 6 edges, (2) Corners 6 edges vall round- (3) Statemed corners 6 edges, (4) Mixture, 50-50' dull and some nev bars.  Statemed, Can, not "Sight", (7) Wostly dull but may have (7) Mixture, 50-50' dull and some nev bars.  Statemed, Can, not "Sight", (8) Sour and the fist of the obstructions and where (12) Stable materials 10-50'.  Less than 5% of the bottom (6) Distribution shift alight. (6) Mostly a lose assortment (6) Mostly and bends.  Reflected by accuring and (8) Gornstelpping.  Less than 5% of the bottom (9) Stable materials 50-50'.  Less than 5% of the bottom (1) Wellow and where (12) Stable materials 20-50'.  Less than 5% of the bottom (1) Wellow and where (12) Stable materials and bends.  Abundant. Growth largely (1) Wellow and where (2) in backwater areas. Season- (3) Roundant most lite, dark green, per- (1) Velocity de pool areas with the source assortment (1) Wellow and where (2) in backwater areas. Season- (3) Bender areas (2) in backwater areas. Season- (3) Bender and bends and		Rocks, old logs firmly	Some present, causing	Noderately frequent, mod	-Ja	Frequent obstructions and	Γ
reps of pool & rifles stable (1) minor pool filling. Obstruc- (4) & deflectors move with high (6) from cutting or and deflectors never (3) water cassing bank cutting deposition.  Little or none evident.  Little or none evident.  Little or none evident.  Little or none chiargoment Some nevi intermittently at Significant. Cuts 12"-24" [And filling of pools. Little or no chiargoment Some nevi intermittently at Significant. Cuts 12"-24" [And filling evident. Cuts 12"-24" [And filling evident. Course sand on corners of course gravels.  Little or no chiargoment Some nevi intermittently at Significant cuts of high generally.  Course gravels.  Sharp edges and corners.  Sharp edges and corners.  Sharp edges and corners.  Sharp edges and corners.  Surfaces such filling filling evident.  Sharp edges and corners.  Surfaces such filling fi	tions	embedded, Flow pattern	-		Suc	deflectors cause bank ero-	
tions and deflectors never 3 water causing bank cutting  Infrequent raw banks less (4) concurves 6 constrictions.  Infrequent raw banks less (5) concurves 6 constrictions of less and on concurs 6 constrictions on construction of less and on concurs 6 constrictions on construction on constructions on construc	Deflectors		A-1-2			sion yearlong. Sed. traps	Ō
Infrequent raw banks less (4) outcurves & constrictions, (8) high, generally, (9) outcurves & constrictions, (9) high, Root mat overlangs (1) framed or non enlargament (4) outcurves & constrictions, (8) high, Root mat overlangs (1) framed or no enlargament (5) formation, most from (1) gravel & coarse sand on (1) formation, most from (1) gravel & coarse sand on (1) formation, most from (1) flat, surfaces and corners, (1) Rounded corners & edges, (2) Corners & edges well round-(1) flat and surfaces roughened, or (1) Mostly dull but may have (2) Mixture, 50-50 dull and sorted sizes tightly, (2) Moderately packed with (4) Mostly dull but may have (5) Mixture, 50-50 dull and sorted sizes tightly, (2) Moderately packed with (3) Moderate change in sizes sortenent (4) Distribution ho change in sizes eightly (5) Moderatelly (6) Moderate change in sizes. (7) Moderatelly (6) Moderate dull, darkened, or (1) Moderatelly Solony, (1) Moderate dull, darkened, or (2) Moderate on the solony or overlapping, (3) Moderatelly (4) Distribution shift slight, (6) Moderate change in sizes. (12) Moderate dull, darkened, or (2) Moderate dull, darkened, but solony and solony overlapping, (3) Moderate dull, darkened, but solony and solony overlapping, (4) Distribution shift slight, (6) Moderate change in sizes eightly (5) Moderate dull, darkened but solony deposition, enlish, in svift water too, there too and svifter waters, lets, dark green, per (1) Velocity & pool areas, Season enlish, in svift water too. (1) Velocity & deposition, enlish, in svift water too. (1) Velocity & deposition, enlish, in svift water too.	ediment Traps		tions and deflectors newer	_	99	full, channel migration	-
Intrequent raw banks less (4) outcurves & constrictions.  Infrequent raw banks less (4) outcurves & constrictions.  Infrequent raw banks less (4) outcurves & constrictions.  Infrequent raw banks less (5) outcurves & constrictions.  Infrequent raw banks less (6) outcurves & constrictions.  Infrequent raw banks less (7) outcurves & constrictions of new letter of than le proint bars.  Infrequent raw banks less (6) formation, most from and slowling evident.  Some new increas in bar (8) gravel & coarse sand on coarse gravels.  Sharp edges and corners, (7) Rounded corners & edges, (7) Corners & edges well rounder (7) Statects dull, darkened, or (1) Rounded corners & edges, (2) Mixture, 50-50% dull and some new bars.  Surfaces dull, darkened, or (1) Rounded corners & edges, (2) Mixture, 50-50% dull and some new bars.  Surfaces roughened, surfaces smooth & flat.  Surfaces dull, darkened, or (1) Rounded corners & edges, (2) Mixture, 50-50% dull and some new bars.  Surfaces dull, darkened, or (1) Roatly dull but may have stained, Gen not "Sright", a loss of some corright surfaces assortment (8) Some overlaping, (8) Some overlaping, (9) Masorted sizes tightly, (9) Masorted sizes tightly, (9) Some overlaping, (9) Stable materials 80-100%, Stable materials 80		deposition,	and less firm.			occuring.	1
Infrequent raw banks less (4) outcurves & constrictions. (8) high, Root mat overhangs (12) than 6" high, generally. Raw banks may be up to 12" and sloughing evident.  Little or no calatygrame. (4) formation, most from and sloughing evident.  Sharp edges and corners, (1) formation, most from old and some new bars. (6) gravel & coarse sand on old and some new bars. (7) gravel & coarse sand on old and some new bars. (7) gravel & coarse sand on old and some new bars. (7) gravel & coarse sand on old and some new bars. (7) gravel & coarse sand on old and some new bars. (8) gravel & coarse sand on old and some new bars. (9) gravel & coarse sand on old and some new bars. (1) velous sand on old and some some some sand on old and some some some sand on old and some some some some some some sand on old and some some some some some some some some			Some, intermittently at			-	_
than 6" high generally, Save banks may be up to 12", and sloughing evident.  Little or no calargament Some new increas in bar Sociate deposition of new of channel or point bars. (4) formation, most from (9) gravels coarse sand on 120 blane surfaces and corners, (1) Rounded corners & edges, (2) Corners & edges well round- (3) surfaces somothe & flat. ed in two dimensions.  Surfaces dull, darkened, or (1) Mostly dull but may have (2) Mixture, 50-50% dull and stained, Cen, not "Dright", up to 35% bright surfaces, (4) Mixture, 50-50% dull and (5) stained, Cen, not "Dright", (2) Moderately packed with (4) Mostly a loose assortment tribution No change in sizes tightly (2) Moderately packed with (4) Mostly a loose assortment tribution on change in sizes evident. (4) Distribution shift slight. (6) Moderate change in sizes well as and or corriging and (6) Constrictions and where (12) & scour at obstructions, deposition.  Less than 5% of the bottom (6) constrictions and where (12) & scour at obstructions, deposition.  Abundant, Growth largely (1) Common, Algal forms in low Present but spotty, mostly charked make rocks slick, dark green, per (1) Velocity & pool areas, Moss (2) in backwater areas, Season—ennials in swift water too. (1) Velocity & pool areas, Moss (2) in backwater areas, Season—ennials in swift water too.		Infrequent raw banks less	(4) outcurves & constrictions.	(8) high. Root mat overhangs	(12	some over 24" high, Fail-	3
Little or no cnlargement Some new increas in bar (a) gravel & coarse sand on (b) gravels.  Sharp edges and corners, (1) Rounded corners & edges, (2) Corners & edges well round- (6) aurifaces undiffered dull but may have (7) Wixture, 50-50 dull and stained, Gen, not "Dright", up to 35% bright surfaces (7) Wixture, 50-50% dull and stained, Gen, not "Dright", (1) Moderately packed with (2) Wixture, 50-50% dull and stained of corners granned gravels stained, Gen, not "Dright", (2) Moderately packed with (b) Moderate ly packed and/or overlapping, (b) Moderately backed with (c) Moderate ly a loose assorbment cribution ho change in sizes evident, (d) Bistribution shift slight, (e) Moderate change in sizes. Stable materials 80-100%, Stable materials 50-80%, Stable materials 80-100%, Stable materials 50-80%, Stable materials 80-100%, Stable materials 60-50%, affected, Deposits on deposition, deposition, deposition, no moderate are seen some constructions, and bends, deposition, deposition in pools.  Abundant, Growth largely Common, Algal forms in low Present but sporty, mostly charges in safety water too, there too and swifter waters, at blooms make rocks slick, and suffice the deposition, entited, in swift water too.		"than 6" high generally.	Raw banks may be up to 12".	and sloughing evident.	)	2	7
of channel or point bars. (4) formation, most from. (8) gravel & coarse sand on 20  Coarse gravels. (1) Rounded corners & edges, (2) Corners & edges well round- Dlane Surfaces roughened, surfaces smooth & flat. ed in two dimensions.  Surfaces dull, darkened, or (1) Rounded corners & edges, (2) Tixture, 50-70% dull and (3)  Surfaces dull, darkened, or (1) Mostly dull but may have (2) Tixture, 50-70% dull and (3)  Statined, Gen. not. "Dright", (2) Moderately packed with (4) Mostly a loose assortment overlap.  Ing. packed and/or overlapping, some overlapping, some overlapping, some overlapping, some overlapping, statined and/or overlap (4) Moderately statine assortment overlap.  East than 5% of the bottom (5) Stable materials 50-80%, stable materials 20-50%, defected by scouring and (6) Constrictions and where (12) & scour at obstructions, and bends. deposition, defend and soffect waters, season ennials in swift water too. There too and swifter waters, at blooms make rocks sick, and ennials in swift water too.		Little or no enlargement			7.0	Extensive deposits of pre-	1
Sharp edges and corners, (1) Rounded corners & edges, (2) Corners & edges well round- (3) plane surfaces roughened, surfaces smooth & flat, ed in two dimensions.  Surfaces dull, darkened, or (1) Mostly dull but may have stained, Gen, not 'Dright', and the construction or stained, Gen, not 'Dright', and the construction of sasoned sizes tightly.  The packed and/or overlapping, criphing and or overlapping, backed and/or overlapping, cribution on change in sizes evident. (4) Distribution shift slight, (5) Moderate change in sizes. (12) Stable materials 80-1002, Stable materials 80-1002, Stable materials 50-802, affected, Deposits feeted by accouring and (6) Comstrictions and where constrictions, and bends. (6) Comstriction, deposition in pools.  Abundant, Growth largely common, Algal forms in low Present but spotty, mostly chark green, per (1) velocity & pool areas, Moss (2) in backwater areas, Season ennials in swift water too. (1) velocity & pool areas, Moss (2) in backwater areas, Season ennials in swift water too.	no	of channel or point bars.	-				3
Sharp edges and corners, (1) Rounded corners & edges, (2) Corners & edges well round- (3) plane surfaces roughened, aurfaces smooth & flat. ed in two dimensions.  Surfaces dull, darkened, or (1) Mostly dull but may have (2) Mixture, 50-50% dull and stained, Gen, mot. Dright, aurfaces, (4) Mixture, 50-50% dull and (5) Moderately packed with (4) Mostly a loose assorbant (6) Moderately packed with (7) Moderate orders in 12 mome overlapping, tribution No change in sizes evident. (4) Distribution shift slight. (6) Moderate change in sizes assorbant orders in 12 mome overlapping. Stable materials 80-100%. Stable materials 80-100%. Stable materials 80-50%. Stable materials 80-100%. Stable 80-100%.			coarse gravels.	rold and some new bars.	8		
Sharp edges and corners,  Sharp edges and corners,  Surfaces smooth & flat,  Surfaces mooth & flat,  Stained, Gen, not "Dright",  Assorted sizes tightly  Cribution  No change in sizes evident,  Came overlapping,  Stable materials 50-80%,  Stable materials 50-80%							
Plane Surfaces roughened,  Surfaces will, darkened, or (1) Mostly dull but may have Surfaces dull, darkened, or (1) Mostly dull but may have Surfaces dull, darkened, or (1) Mostly dull but may have Stained Gen, not "Dright",  Rasorted sizes tightly Fraibution No change in sizes evident, (4) Modrately packed with No change in sizes evident, (4) Distribution shift slight, (8) Modrate change in sizes Haterials Stable materials 80-1007, East than 5% of the bottom  Stable materials 80-1007, Stable materials 10-507, Stable materials 20-507, Stabl	sularity	Sharp edges and corners,	(1) Rounded corners & edges,	(2) Corners & edges well rou	-	(3) Well rounded in all dimen-	4
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Add the values in each column for a total reach score here. (E. 2 + G. 14 + F. 73 + F. 8 - 97).

Reach score of: (38-Excellent, 39-76 "Good, 77-114" Fair, 115+-Poor.



year, the latter peak being reduced each year as the rain gauge had been disturbed. Precipation values for the East Fork precipitation station apparently exceed those of either of the weather stations

### Stream Discharge

The staff-discharge rating curves for the Lower Clark Canyon and Upper Clark Canyon sampling stations are presented in Figures 26 and 27. The channel section at the upper station remained relatively stable throughout the sampling period, but the lower station experienced moderate channel erosion near the staff. A staff-discharge rating curve was not generated for the East Fork station owing to severe channel instability.

The 1977 and 1978 annual hydrographs for the Clark Canyon Creek sampling stations are presented in Figures 28-32. A hydrograph for the East Fork for 1977 is not included because of the erratic discharge values caused by channel instability, flash flooding, and irrigation diversion. Peak flow during 1977 at the Lower Clark Canyon station apparently occurred in early to mid-April. An estimated crest stage value of 5.2 cfs in mid-April may have been superseded by a higher value during an unusually warm period in early April. Lowest flows were recorded in August and September at 0.26 cfs. An estimated peak flow in excess of 9.4 cfs occurred during mid-May, 1978, which was preceded by an annual low flow of 0.12 cfs in mid-April. The erratic discharge patterns at this station are primarily attributed to the widespread irrigation diversion of stream water between the East Fork and Lower Clark Canyon stations. An early peak flow of 14 cfs occurred at the Upper Clark Canyon station in 1977, however, this value may be overestimated owing to residual ice conditions in the sampling reach. A later peak flow of 8.7 cfs was noted for mid-June. Lowest recorded flow for the year was



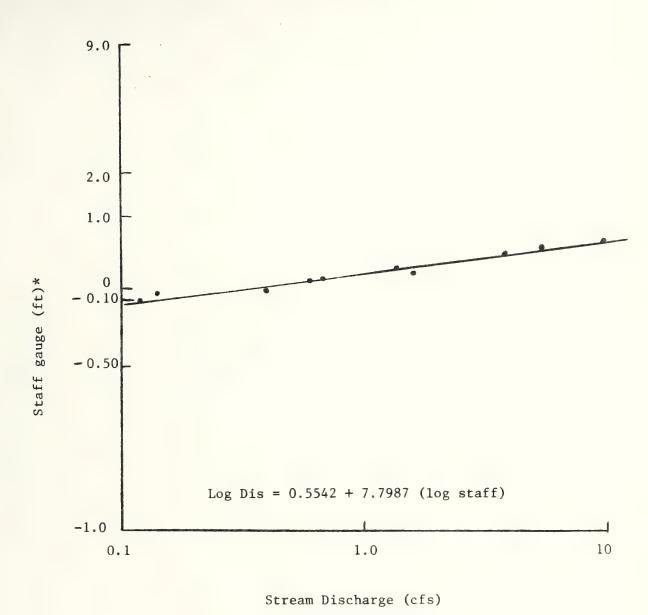
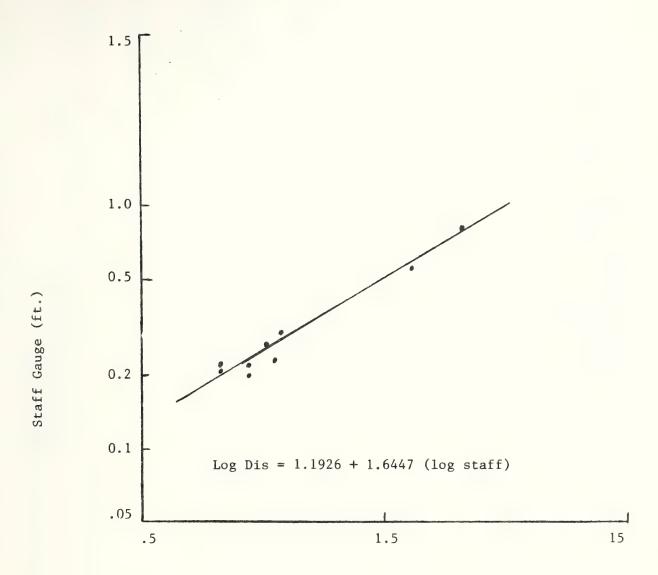


Figure 26. Staff-discharge Rating Curve for Lower Clark Canyon Sampling Station.

<sup>\*</sup> Owing to actual negative readings, 1.0 feet must be added to each recorded value when using this rating curve.





Stream Discharge (cfs)

Figure 27. Staff-discharge Rating Curve for Clark Canyon Sampling Station.





66 0.000.0 375.0000 300.000 225.0000 150.0000 75.0000 075.0006 525.0000 450.0000 750.0000 0000 - 009 SEP 30 SOY : : JUN : LOWER CLARK CANYON - 1978 FIGURE 29. ANNUAL HYDROGRAPH AND SEDIMENT EDADINGS \* APR \* 25.0600+ \* PEB \* DEC : \*+6000.0 7.5000+ 2.500+ 20.000 12.5003+ 10.000.01 5.0000 22.5000 .7.530. 15.000 

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FIGURE 30. ANNUAL HYDRIGRAPH AND SEDIMENT LUADINGS

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68 0.0000 375.0000 75.0000 £25.0000 300.000 225.0000 156.0000 750.0000 075.4000 0000.009 450.0000 SEP 30 : AUG UPPER CLARK CANYON - 1978 : FEB : DEC \*+0000.0 25.0000+ + COS-LT 15.0003+ 12.5000+ 5.0000+ 22.5000 20.0000 10.0004 7.53034 2.50004 

FIGURE 31. ANNUAL HYDRJCRAPH AND SEDIMENT LOADINGS



69 0,000.0 300.0000 150.9000 + 1350.0000 + 1050.0000 900,0000 754.0000 600.000 450,0000 + 1500.0000 1200.0000 SEP 30 : AUG S AUA S EAST FORK CLARK CANYON - 1978 (11,500) : APR e FEB DFC 0.0000+ 1.5000+ 5.0000+ 4.0000+ \*\* C . C . A 3.5666+ 3.0000+ 2.5993+ 2° 0000+ P. 5000+ 4.5000. 

FIGURE 32. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS



0.69 cfs in mid-September. Peak flow in 1978 arrived during mid-May with an estimated 20 cfs, while the annual lowest flow was recorded at 0.76 cfs the preceeding November. Discharge values at the initial East Fork sampling station ranged from peak flow that would have been well in excess of 2 cfs in early April to a trickle in July and August. Peak recorded flow for the East Fork station for 1978 at its new location was 2.6 cfs in mid-May, while the low annual flow of 0.10 cfs occurred in late June. The differences noted in flow patterns for the two hydrologic years are largely attributed to differences in the annual precipitation patterns, although the East Fork station responded specifically to individual storm periods.

The respective annual hydrograph data were used to estimate the annual water yields for each station (Table 10). In both years, the estimated yield for the Lower Clark Canyon station was slightly below that of the Upper station owing to largescale irrigation diversions. Yields for the two year study period were comparable, ranging from 980 acre feet to 1,250 acre feet. Discharge for one large storm period in May, 1978 may have overestimated the 250 acre feet water yield figure for the East Fork station.

## Suspended Sediment

The annual patterns of sediment concentration for each station by hydrologic year are depicted in Figures 28-32. Suspended sediment concentrations at the Lower Clark Canyon station ranged from 7 ppm at low flow to 744 ppm at high flow, the Upper station from 7 ppm to 525 ppm, while the East Fork station values extended from 15 ppm to 11,500 ppm. Higher suspended sediment values were recorded during the 1978 hydrologic year when there were higher discharge values. The relationships between suspended sediment and stream discharge for Lower Clark Canyon and Upper Clark Canyon were statistically significant, and are presented in Figures



Table 10 Estimated Water and Sediment Yields for the Clark Canyon Sample Basin, 1977 - 1978.

Station Name	Water Year	Estimated Water Yield (ac ft.)	Estimated Sediment Yield (tons)	Contributing Watershed (acres)	Runoff (in. / ac.)	Sediment Yield (lbs/acre)
Lower Clark	1977	086	89	9,730	1.21	9.93
	1978	1,020	227	9,730	1.26	7.97
Upper Clark Canvon Station	1977	1,110	81	5,380	2.48	29.9
	1978	1,250	127	5,380	2.79	47.2
East Fork Clark Canyon Station	1977	N/A	I	1	1	1
,	1978	250	410	1,660	1.80	200



for the East Fork station for 1978 was not significant, primarily owing to the variability of the data and the small sample size. This variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effects, and especially to the hysteresis effect, whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973, pp. 215-219). Annual sediment yields for those sample stations were estimated from respective water yield and sediment concentration data (Table 10). The Lower and Upper stations produced approximately 48 tons and 81 tons of suspended sediment respectively during 1977. These yields were increased to 227 tons and 127 tons for the more active 1978 hydrologic year. The estimated suspended sediment yield of 250 tons for the East Fork is an approximation based on an adjusted figure for the storm period encompassing May 9, 1978.

# Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lower concentrations occur during periods of high runoff, while higher concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Walling, 1973, pp. 219-225). Patterns for specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et al., 1977, pp. 74-76).

Specific conductance for the Lower Clark Canyon station ranged from a low of 284 µmhos during high spring runoff to a high of 515 µmhos during late summer base flow. The Upper Clark Canyon station exhibited a much greater seasonal variation, values ranging from 205 µmhos to a high of 427 µmhos, while the East Fork station ranged from 178 µmhos to 600 µmhos.



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FIGURE 34. SUSPENDED SEDIMENT VS STREAM DISCHARGE - UPPER CLARK CANYON

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FIGURE 35. SUSPENDED SEDIMENT VS STREAM DISCHARGE - EAST FORK CLARK CANYON

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The relationships between specific conductance and stream discharge for each station were statistically significant and are presented in Figures 36-38. Variation in specific conductance with stream discharge is partially attributed to seasonal and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225). The ranges in ionic concentration for specific ions are presented in Table 11.

#### Bacteria Levels

The concentration of fecal and total coliform in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising stage (Kunkle and Meiman, 1968), with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their own "flushing" effect, and which may or may not be followed by a short term dilution period.

The concentrations of fecal coliform for the Clark Canyon Creek sampling stations for the study period are presented in Table 12. Higher values generally occurred during the grazing season, especially at the Lower and Upper stations with the known present of livestock. The data indicate that livestock were present in the East Fork watershed. Maximum fecal coliform levels were 409, 387, and TNTC colonies/100 mls respectively for each station. Approximately 8 percent of the sample colonies counts in Lower Clark Canyon, 8 percent in Upper Clark Canyon, and 33 percent in the East Fork exceeded



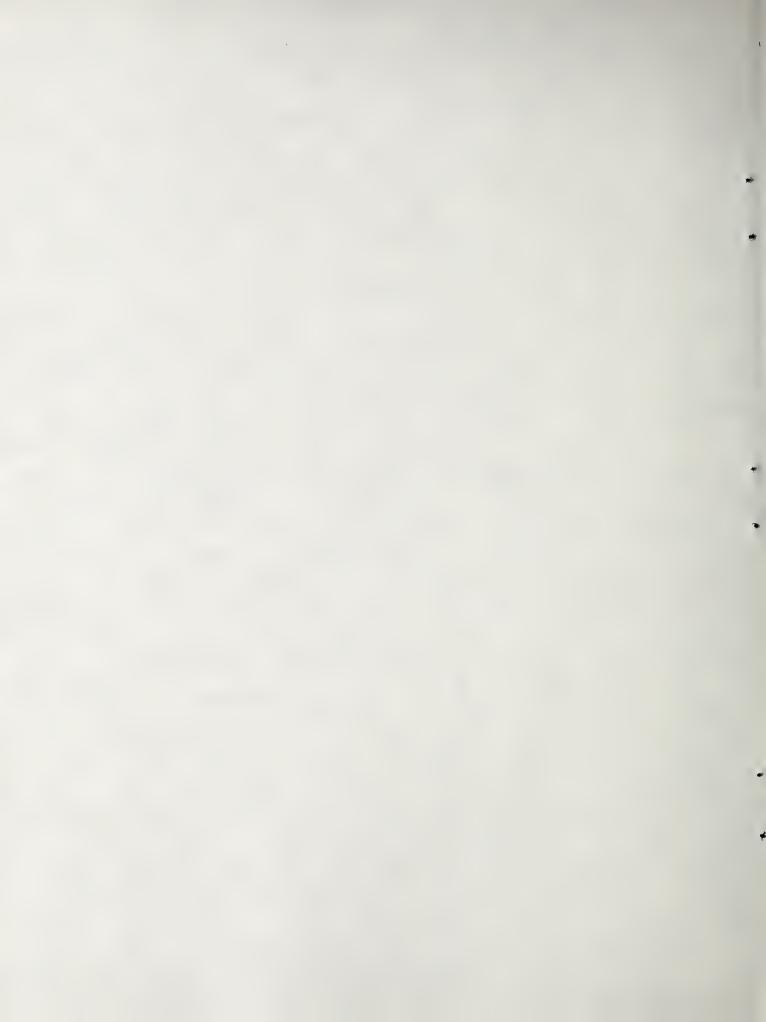
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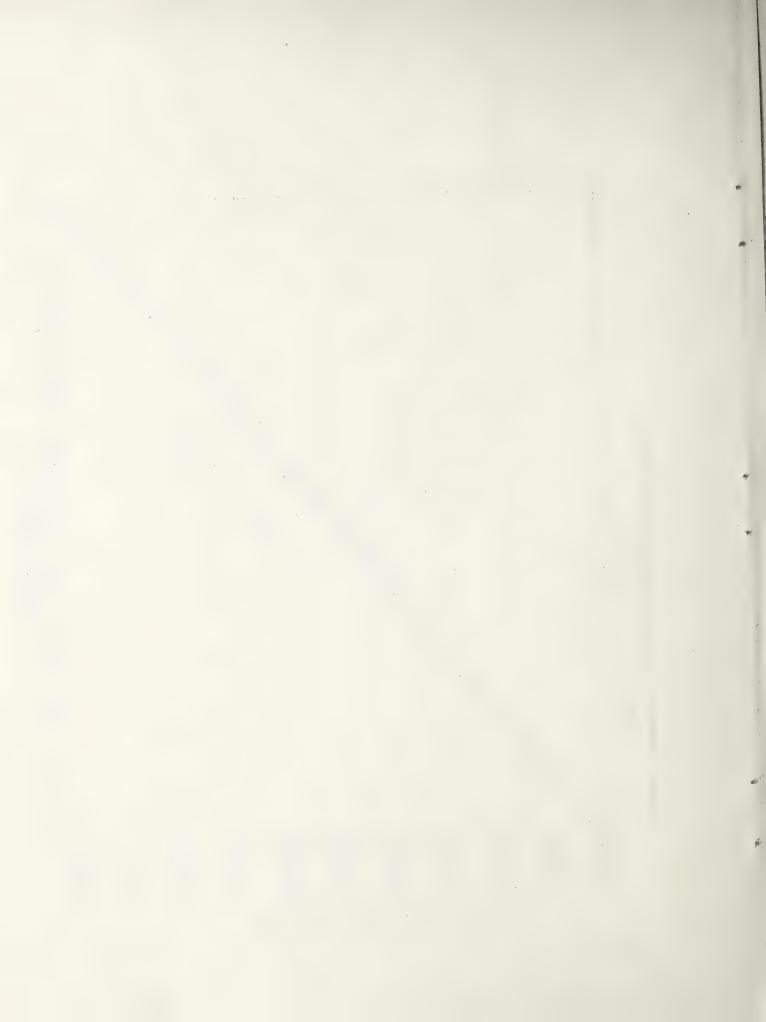


PICURE 37. CONDUCTIVITY VS STREAM DISCHARGE - UPPER CLARK CANYON

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FIGURE 38.

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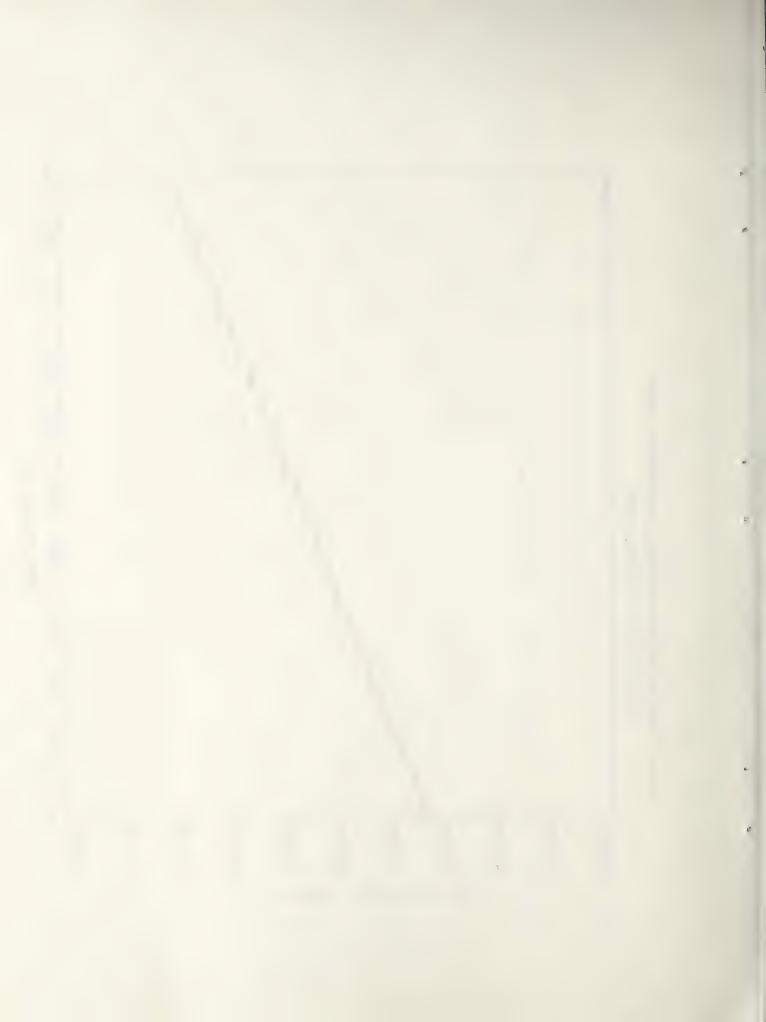


Table 11 Ranges in Hydrochemical Parameters for the Clark Canyon Creek Sampling Stations, 1977 - 1978.

		Upper Clark Canyon	East Fork Clark Canyon
pH	7.70 - 8.27	7.76 - 8.20	7.70 - 8.37
Alkalinity (CaCO <sub>3</sub> ) (mg/1)	148 - 275	111 - 214	85 - 281
Specific Conductance (umhos)	284 - 515	205 - 427	178 - 600
Total Dissolved Solids (mg/l)	185 - 335	133 - 278	116 - 390
Ca (mg/1) Mg (mg/1) Na (mg/1) K (mg/1) HCO <sub>3</sub> (mg/1) SO <sub>4</sub> (mg/1)	37 - 92	24 - 78	19 - 64
	4.1 - 8.4	3.3 - 7.4	2.7 - 11
	17 - 31	10 - 19	15 - 58
	1.4 - 5.6	1.3 - 3.5	2.9 - 8.5
	178 - 336	136 - 260	102 - 343
	4 - 12	3 - 9	5 - 32
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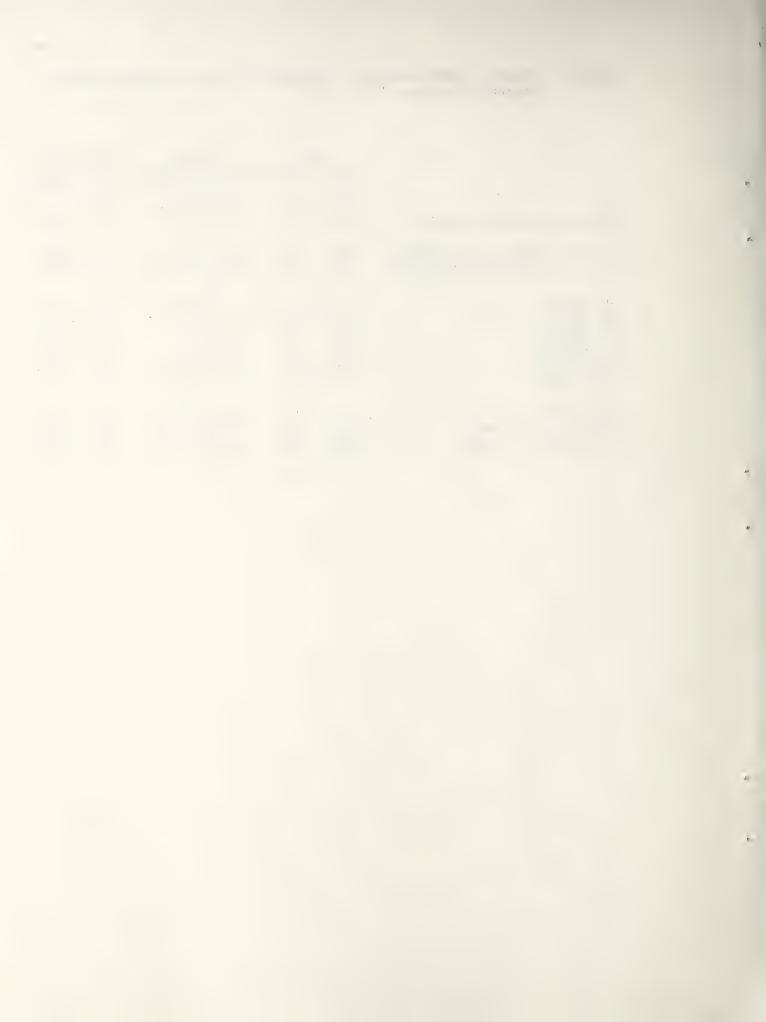


Table 12 Fecal Coliform Counts (colonies 100/mls) for the Clark Canyon Creek Sampling Stations, 1977 - 1978.

	Lower Clar	k Canyon	Upper Cla	rk Canyon	East E Clark C	
,	1977	1978	1977	1978	1977	1978
April						
May	∠2	<b>∠</b> 1	< 2	1	4(?)	3
June	8(?)	409*	8(?)	9	8(?)	28(?)
July	14*	100(?)	<b>&lt;</b> 2 *	387*	940(?)	267(?)
August	2*	83(?)	8(?)	33*	140(?)	303(?)
September	143*	87(?)	14*	9(?)	TNTC(?)	33(?)
October	51*		7(?)		5*	
November	58*		17(?)		65*	

<sup>\*</sup> Stock visually present.

<sup>(?)</sup> Stock presence uncertain.



the 200 colony/100 ml limit of the Montana Water Quality Criteria. Low values were associated with the spring season.

## Comments

While the Upper Clark Canyon station reflects characteristic hydrologic patterns, the Lower and East Fork stations reflect contrasting patterns. The Lower station is strongly influenced by the effects of irrigation diversion and several elevated sediment concentrations may be attributed to the presence of livestock. The East Fork of Clark Canyon is steep and faces to the southwest. It is prone to rapid runoff during storm periods or during early spring melt. The channel is unstable and is constantly altering its morphonetry. This small stream carries disproportionally large quantities of suspended sediment as well as bed load. Because of the limited number of samples taken and the nature of the hydrochemical parameters evaluated, relationships between the water quality characteristics of Clark Canyon Creek and the Montana Water Quality Criteria cannot be addressed.

# Little Sage Creek Basin

The Little Sage Creek sample basin was visited a total of 16 and 17 times during the two hydrologic years. There were no specific accessibility or sampling problems.

### Channel Stability Ratings

The Little Sage Creek stream section was evaluated on August 15, 1976.

That portion of Little Sage Creek upstream from the sampling station for approximately 4 1/2 miles was rated as 'good' (67) (Table 13).



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Item Rated		Statility Inc	Stability Indicators by Classes	
I. UPPER BANKS	EXCELLENT	0000	PAIR	POOR
Landform Slope	Bank slope gradient (30%,	10 Bank slope gradient 30-40%	(4) Bank slope gradient 40-607, (	(6) Bank slope gradient 607, + 3
	No evidence of past or	27:3	1 : 2	
(Extering or Potential)	potential for future mass	(3) Mostly healed over. Low		(9) sediment rearly yearlong OR 1/2
(1817)	wasting into channels.	-	by water during high flows.	
Debris Jam Potential	Essentially absent from	(2) Present but mostly small	9215	(6) Moderate to heavy amounts, O
(Floatable Objects)	immediate channel area.	twigs and limbs.	are both increasing.	
Bank Protection	90% + plant density, Vigor	70-90% density. Fewer plant		< 50% density plus fewer
from	and variety suggests a	(3) apecies or lower vigor	and still fever species	(9) species & less vigor indi- 1,3
Vegetation	deep, dense root mass.	suggests a less dense or	form a somewhat shallow and	•
11 LAKE RANKS		deep root mass.	discontinuous toot mass.	and shallow roof mass.
1	Ample for present alice some	Advantage Outside 61 as	100000000000000000000000000000000000000	
Channel Capacity	Increases, Peak flows con-	(1) rare. Width to Depth (W/D)	ank	(3) common. W/D ratio >25.
	tainec, w/D ratio < /.	racto 6-13.	1	-
Bank Rock Content	165% + with large, angular boulders 12" + numerous.	(2) 40 to 65% mostly small boulders to cobble 6-12"	(4):20 to 40%, with most in the (	(6) < 20% rock fragments of
	Rocks, old logs firmly	Some present, causing	Moderate's frequent, moder-	Frequent obstructions and
Obstructions	embedded. Flow pattern	- 1-84	aftely unstable obstructions	
Flor Deflectors	of pool & riffles stable	2 minor pool filling Observe-	(4) & deflectors move with high	(6) sion year long Sed trans
Sediment Trans	without cutting or		. water causing bank cutting	full channel mieration
ederr rieben		and less firm.	sand filling of pools.	occuring.
	Little or none evident.	Some, intermittently at	Significant, Cuts 12"-24"	Almost continuous cuts.
Cutting	Infrequent raw banks less	(4) outcurves & constrictions.		(12) some over 24" high, Fail- 16
	"than 6" high generally,	Raw banks may be up to 12",	(6) and sloughing evident.	· Jure of overhangs frequent,
	Little or no enlargement		"Noderate deposition of new	ı
Deposition	of channel or point bars.	(4) formation, most from	uo	(12) dominately fine particles. /6
NOTION IN		coarse gravels.	Viold and some new bars.	Accelerated bar development,
TIL BOTTON	- 1		F	
Rock Angularity	Sharp edges and corners,	(1) Rounded corners & edges,	(2) Corners & edges well round- (	(3) Well rounded in all dimen- 4
Brightness	Surfaces dull darkened or	(1) Corto dell' but met here	200	A President sources smooths
	stained, Gen, not "Sright",	-	bright, ± 15%, 1e 35-65%.	exposed or scoured surface
Consolidation or	Assorted sizes tightly	(2) Moderately packed with		(6) No packing evident, Loose 9
Particle Packing	packed and/or overlapping.	-	with no apparent overlap.	assortment, easily moved.
Bottom Size Distribution		(4) Distribution shift slight.		Marked distribution change. 1/
o rercent Stable Materials Stable materials	Stable materials 80-100%	Stable materials 50-80%.		Stable materials 0-20%.
	Less than 5% of the bottom	5-30% affected, Scour at	30-50% affected. Deposits	More than 50% of the bottom
Scouring and	streeted by scouring and	ere		(18) in a state of flux or change 24
Deposition	deposition.	grades atcepen. Some	ds.	nearly yearlong.
Clean Asset C	Abrildant Constitution	nepostation in pools	Some riviing or pools	
Verent Verent	more like dark even neve	Common, Algal Iorns in Low	rresent but sporty, mostly	rerenntal types scarce or
(Hosa & Algae)	ennial, In swift water 100.	There too and suffer unfers		from blom say he present
	COLUMN TOTALS		100	
		3,000		)

Add the values in each column for a total reach score here. (E. 8 + G. 34 + F. 8 + P. 7 - 67).

Reach score of: (38-Excellent, 39-76-Good, 77-114- Fair, 1154-Poor.



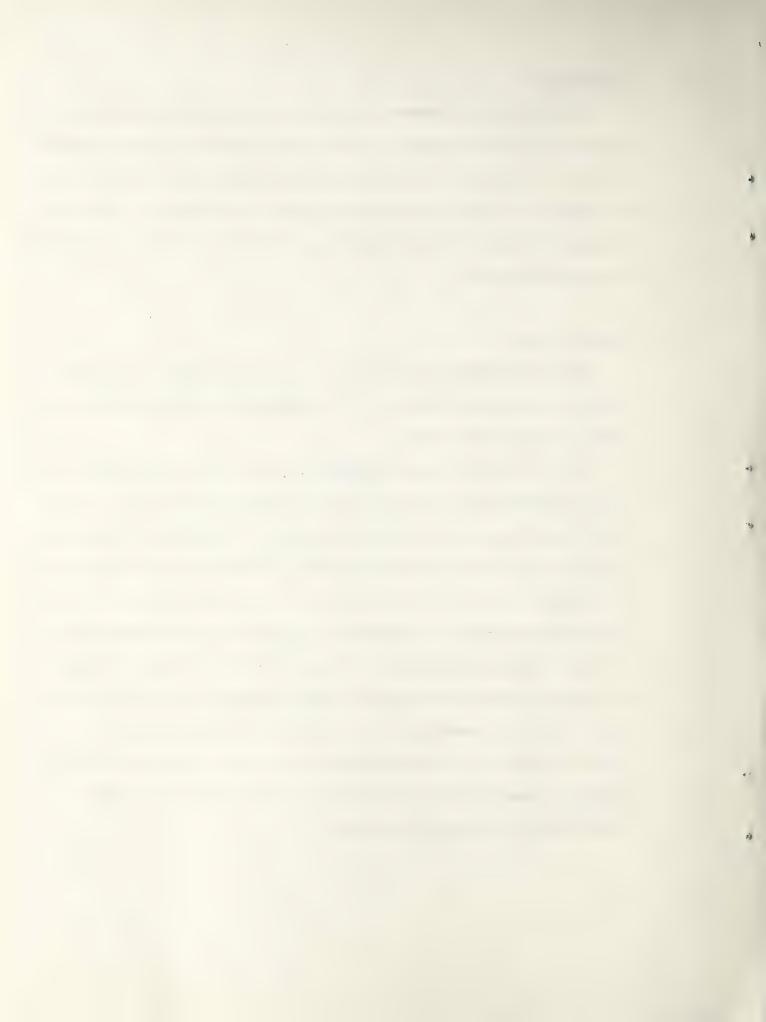
### Precipitation

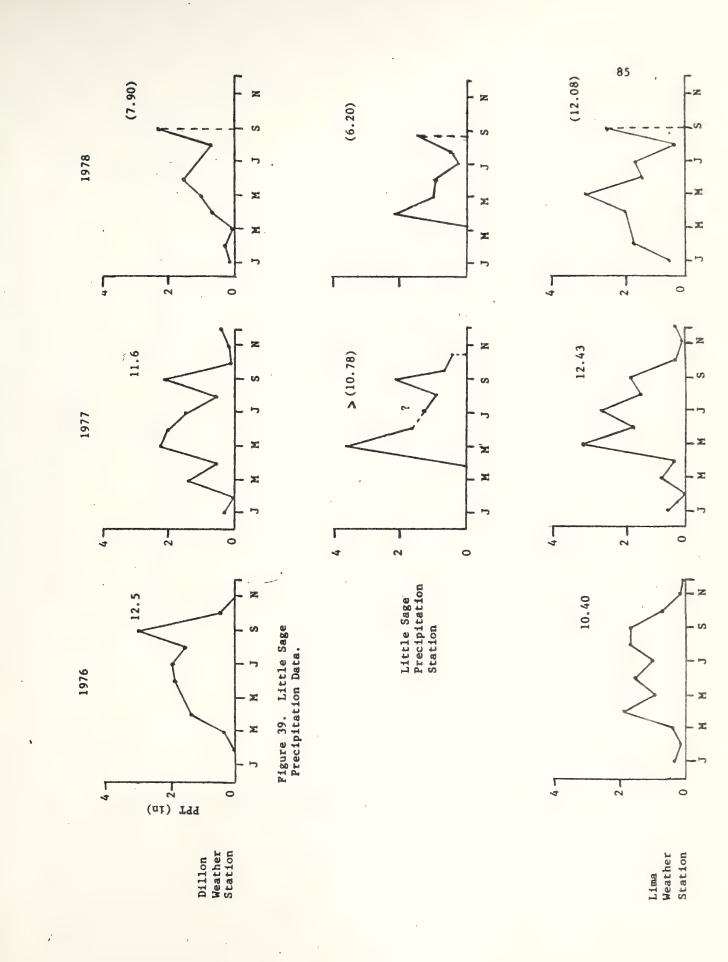
Precipitation was measured at the Little Sage precipitation station from April 21 through November 13, 1977 and from April 4 through September 11, 1978. The general precipitation patterns during these two fiscal years are compared to those of the Dillon and Lima weather stations (Figure 39). Although 1977 was the wetter year, both years indicate a peak in precipitation for May and September.

## Stream Discharge

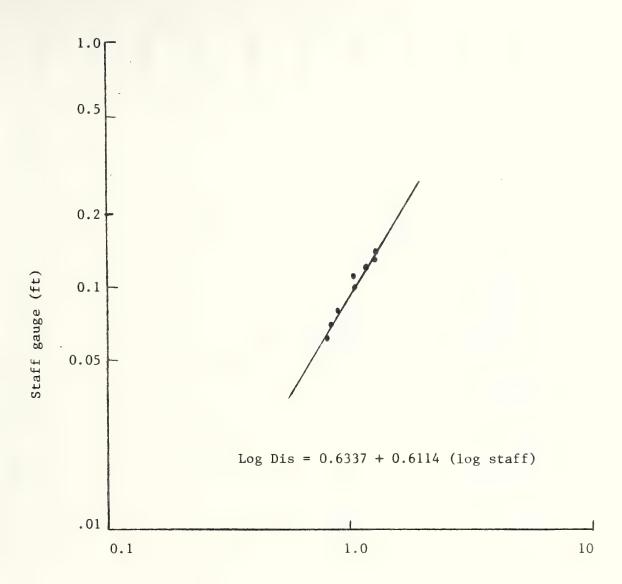
The staff-discharge rating curve for the Little Sage Creek sample station is presented in Figure 40. The guaging site remained nearly stable during the two sampling years.

The 1977 and 1978 annual hydrographs for the Little Sage Creek sample station are presented in Figures 41 and 42. Peak flow during 1977 at the Little Sage station was recorded in late April. An estimated crest stage value of 3.5 cfs was recorded at this time, although a higher flow may have occurred prior to the first sampling visit. The crest stage peak flow may be overestimated owing to residual ice conditions around the staff guage. The lowest recorded flow during 1977 was only 0.69 cfs during early May. The 1978 year produced no discernible peak, although one may have occurred prior to the first sampling visit. The lowest recorded flow for 1978 was 0.50 cfs in mid-July. The differences noted in flow patterns for the two hydrologic years are largely attributed to differences in the annual precipitation and snow melt patterns.









Stream Discharge (cfs)

Figure 40. Staff-discharge Rating Curve for Little Sage Sampling Station.



87 30.000 0.000 50.000 100.0000 0000 . 96 70.0000 60.0000 40.0000 26.0000 10.0000 80.000 SEP 30 : AUG JUN : • FIGURE 41. ANNUAL HYDRIGRAPH AND SEDIMENT LOADINGS \* APR \* LITTLE SAGE - 1977 \* FER \* 3 DEC 10.00.01 OCT 1 0.000.0 4.000.F 5.0000+ 4.0.0.4 3.0303+ 1.0000+ +~1010 +0000°9 45050.0 2.0000 



88 90.000 0,000 10.0000 56.0000 00000.00 30.0000 100.0000 80.0000 10.0000 40.0000 20.0000 SEP 30 SUA : NUC: • FIGURE 42. ANNUAL HYDRJGRAPH AND SEDIMENT LOADINGS LITTLE SAGE - 1978 . APA FEB DEC T 129 \*+0~0000 10.0000+ 1.000.1 9.cutu+ 4 ~ O ~ O ~ 9 4.0000+ 7.0903+ 5.0000 2.0000 8.0JPJ+ 3.6,000 



The respective annual hydrograph data were used to estimate the annual water yields for the Little Sage Creek Table 19, see p. 111). In both water years the estimated yield was 780 acre feet. This condition is partially attributed to the gentle topography of much of the basin, and to the possible ommission of a recorded spring peak flow for one or both sampling years.

### Suspended Sediment

The annual patterns of sediment concentration for the Little Sage for each hydrologic year are depicted in Figure 41 and 42. Suspended sediment concentrations at the station ranged from 5 ppm at low flow to a high of 99 cfs which was not associated with high discharge values. The relationships between suspended sediment and stream discharge for this station were not statistically significant (Figure 43). The variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effects, the presence of livestock in and near the stream, and to the hysteresis effect, whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973, pp. 215-219). Annual sediment yields for the sample station were estimated from respective water yield and sediment concentration data (Table 19, see p. 111). The station produced approximately 31 tons and 21 tons of suspended sediment respectively during the study years. These differences are partially attributed to differences in the precipitation and hydrologic regimes between the two years.

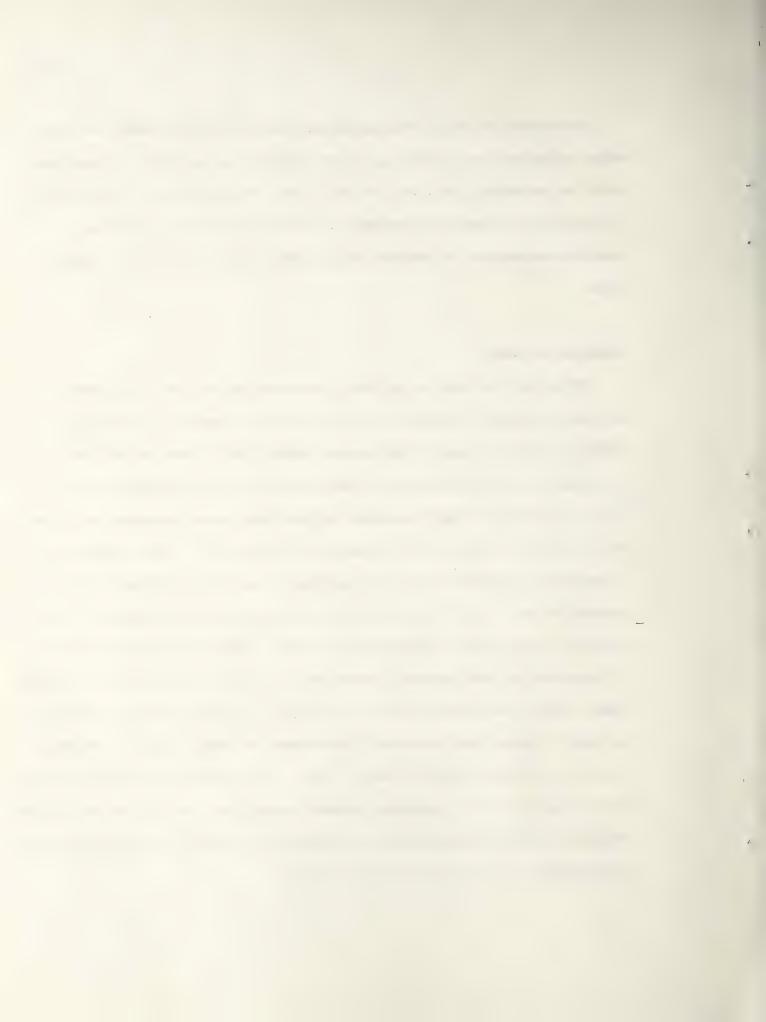


FIGURE 43. SUSPENDED SEDIMENT VS STREAM DISCHARGE - LITLE SAGE

P 33.3629+  B 33.3629+  C 20.2141+  S S		E AND AND THE STATE OF THE PERSON OF THE PER						Particular or warmen or commercial	
2.7241 1.6500 1.0000	0,251	0.399	0.631	A.631 1.000 STREAM DISCHARGE :CFS:	1.595	2.512	3.991	۷- ۱۱ س ا ۱۰	90

TSOME AND SOUTH THE SOUTH BOTH



### Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lower concentrations occur during periods of high runoff, while higher concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Ralling, 1973, pp. 219-225). Patterns for specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et al., 1977, pp. 74-76).

Specific conductance for the Little Sage station ranged from a low of 292 µmhos to a high of 428 µmhos. The relationships between specific conductance and stream discharge for the Little Sage station were not statistically significant (Figure 44) and did not conform to the pattern noted above. The variation in specific conductance with stream discharge is believed to be primarily attributed to the low slope - low runoff conditions of the basin and secondarily to the usual seasonal and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225). The ranges in ionic concentration for specific ions are presented in Table 14.

# Bacteria Levels

The concentration of fecal and total coliform in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising stage (Kunkle and Meiman, 1968), with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from

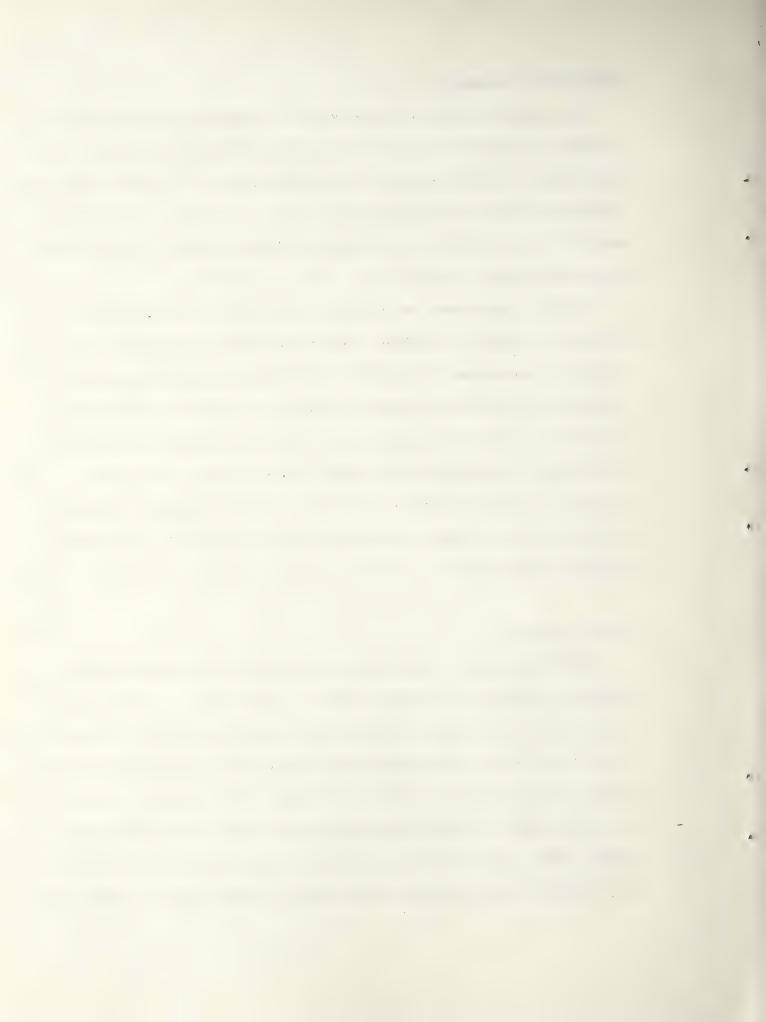


FIGURE 44. CONDUCTIVITY VS STREAM DISCHARGE - LITTLE SAGE

STREAM DISCHARGE : CFS:



Table 14. Ranges in Hydrochemical Parameters for Little Sage Creek, 1977 - 1978.

	Little	Sage
pH Alkalinity (CaCO <sub>3</sub> ) (mg/1)	7.70 - 148 -	
Specific Conductance (umhos) Total Dissolved Solids (mg/1)	292 - 190 -	
Ca (mg/1) Mg (mg/1) Na (mg/1) K (mg/1) HCO <sub>3</sub> (mg/1) SO <sub>4</sub> (mg/1)	38 - 7.3 - 9.8 - 5.4 - 170 - 2 -	11 14 8.5 256
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	<.0101 - T -	



the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their own "flushing" effect, and which may or may not be followed by a short term dilution period.

The concentrations of fecal coliform for the Little Sage station for the study period are presented in Table 15. Higher values occurred during the grazing season, especially with the known presence of livestock. Maximum fecal coliform levels were 2,000 colonies/100 mls. Twenty-five percent of the sample coliform counts exceeded the 200 colony/100 ml limit of the Montana Water Quality Criteria. Low values were associated with the spring season.

#### Comments

Little Sage Creek is a very gentle, high elevation, dryland basin.

This suite of environmental conditions may retard the normal annual flushing effect encountered in other environments. Thus, neither suspended sediment concentration nor conductivity was correlated with stream discharge. In addition, there is some indication that livestock influenced sediment concentrations on several occasions. Because of the limited number of samples taken and the nature of the hydrochemical parameters evaluated, relationships between the water quality characteristics of Little Sage Creek and the Montana Water Quality Criteria cannot be addressed.

### Basin Creek Basin

The Basin Creek Sample basin was visited a total of 16 and 17 times during the two hydrologic years. There were no specific accessibility or sampling problems. The Upper Basin and Little Basin monitored 15 and 17 times respectively.

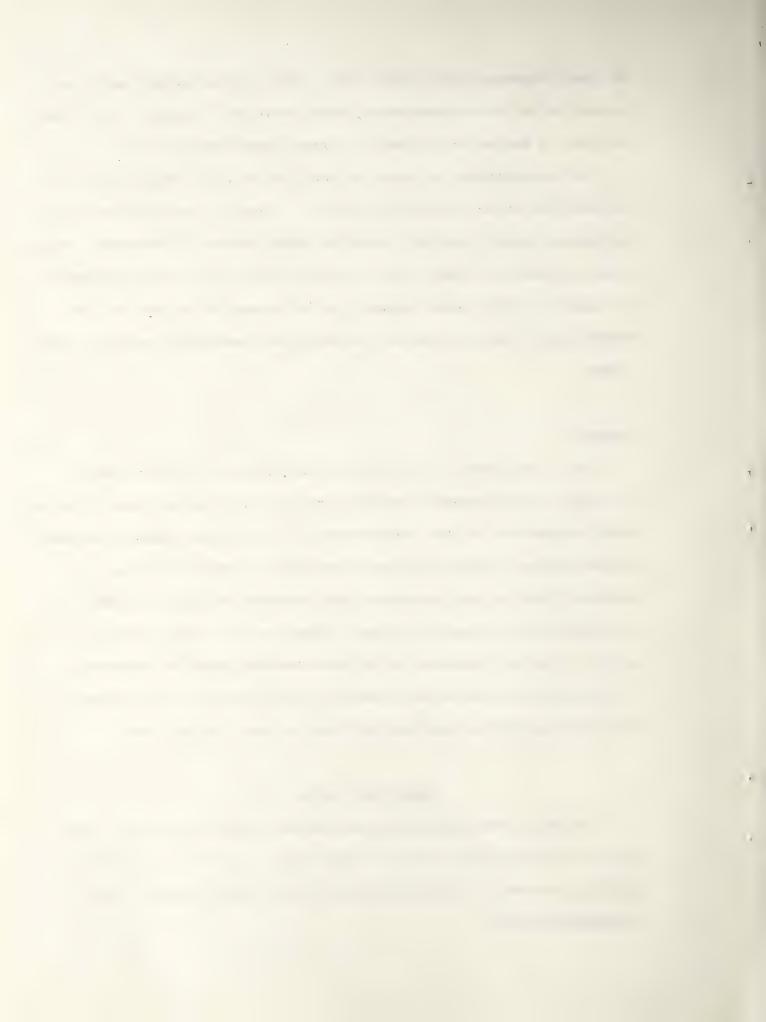


Table 15. Fecal Coliform Counts (colonies/100 mls) for Little Sage Creek, 1977 - 1978.

	Little	Sage
•	1977	1978
April		
May	12(?)	2
June	390*	17(?)
July	488*	29(?)
August	50(?)	85(?)
September	9(?)	2000 *
October	18*	
November	8*	

<sup>\*</sup> Stock visually present.

<sup>(?)</sup> Stock presence uncertain.



### Channel Stability Ratings

The Lower Basin Creek, Upper Basin Creek, and Little Basin Creek stream sections were evaluated on August 16, 1976. That portion of Basin Creek between the lower station and the two tributary stations was rated as 'good' (49) (Table 16), Upper Basin Creek as 'good' (74) (Table 17), and Little Basin Creek as 'good' (67) (Table 18).

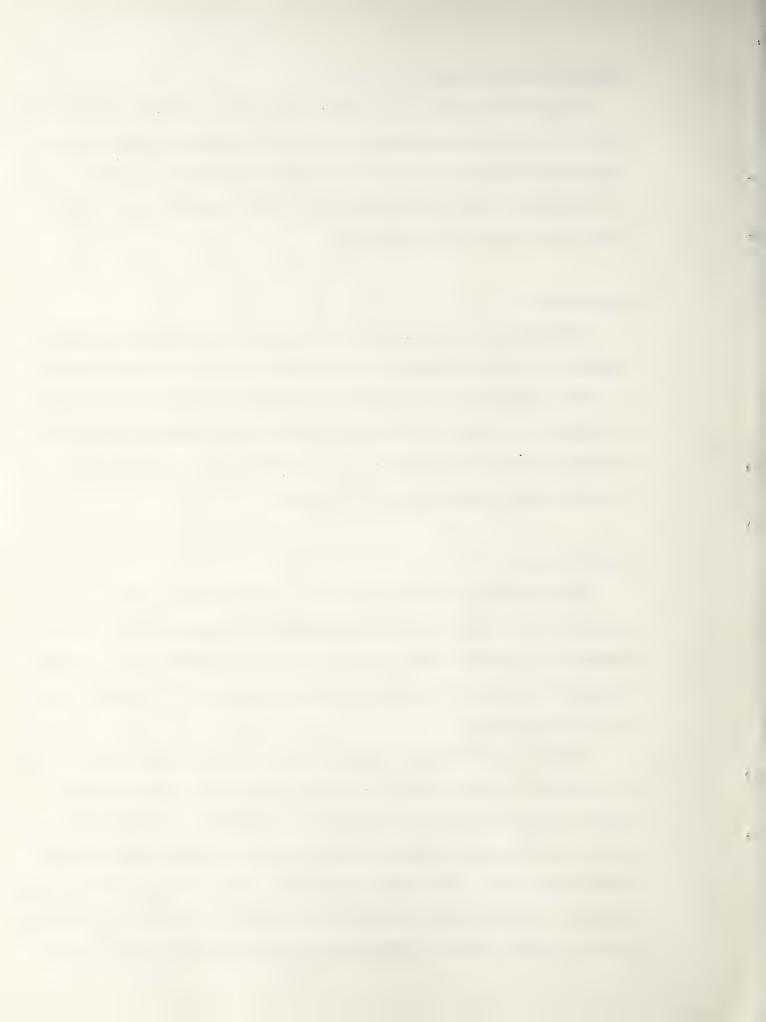
### Precipitation

Precipitation was measured at the Upper Basin precipitation station from April 21 through November 13, 1977 and from April 4 through September 11, 1978. The general precipitation patters during these two fiscal years are compared to those of the Dillon and Lima weather stations (Figure 45). Apparently 1977 was the wetter year for the Basin Creek station, primarily owing to greater precipitation in the spring.

## Stream Discharge

The staff-discharge rating curves for the Lower Basin, Upper Basin and Little Basin sample stations are presented in Figures 46-48. The gauging sites remained nearly stable during the two sampling years. Rocky substrate in Lower and Upper Basin stations caused low flow threshold values in the rating curves.

The 1977 and 1978 annual hydrographs for the Basin Creek sample stations are presented in Figures 49-54. Peak flow during 1977 at the Lower Basin station apparently occurred in mid-April. An estimated crest stage value of 15 cfs was recorded; however, residual ice in the channel may have overestimated this flow. The lowest recorded flow during 1977 was 0.49 cfs during mid-July. The 1978 year produced an early peak flow of 6.7 cfs in late-April which preceded a possibly overestimated seasonal peak discharge of 14 cfs

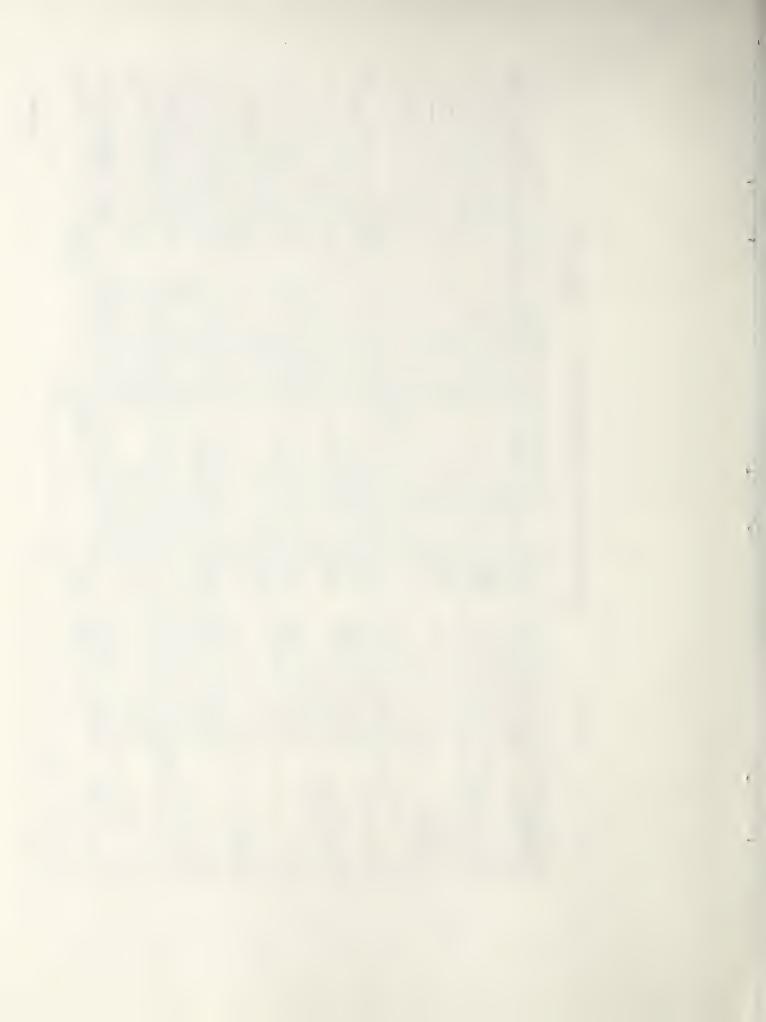


Lower Basin 8/16/76

WITTON MANNESS   STATE   Standard Dogs Kraileng COTO   Standard Dogs COTO   Standard Dogs Kraileng COTO   Standard Dogs Krai	Item Rated			Stacility Ind	icato	Stanility Indicators by Classes			
No evidence of past or infrequent and/or variant (0) Waterial Erequency 6 size, (0) Grain times travers of past or infrequent and/or variant (0) Waterial Erequency 6 size, (0) Greater to relating the foreign to channel or infrequent and/or variant (0) Waterial Erequency 6 size, (0) Greater to relating the foreign to channel area, (0) Greater to mostly manifold over the foreign to channel area, (0) Greater to channel ar	BANKS	EXCELLENT	003	00	E-1	FAIR	Г	POOR	
Noderto Frequence of parts (1)   Noderto Frequence   Noderto Fre	m Slope	Bank slope gradient < 30%	(1) Bank slope grad	-	(4)	Bank slope gradient 40-60%	9	Bank slope gradient 60% +	Ø
Treating the channel area   Present but mostly and   Present, volume and size   Orderize to heavy amounts      Its teach ally absent from   Present but mostly and   Present, volume and size   Orderize to heavy amounts	sting	No evidence of past or potential for future mass		small <sub>p</sub>	(9)	loderate frequency & size, with some raw spots eroded	(6)	5	2
interest to the forest but mostly small (N) Present, volume and size (D) Colociate to the key amounts, are both interesting to the forest but mostly small (N) and still fewer species (O) CONG density, Fewer plant (O) and still fewer species (O) CONG density, New (O) density (O) d	ting or Potential)	wasting into channels.	Calfuture potentia		,D	y water during high flows.			1
90% + plant density Nigor   Congress a less drave or lover vigor   Congress and services and services of services	Jam Potential	Essentially absent from	William .	stly small	(y)	resent, volume and size	(9)	Noderate to heavy amounts,	20
deep, dense roof mass. Operies or lover vigor to mass and variety spaces of lose vigor to mass. Season of lose vigor to mass. Operies of lover vigor to mass. Operies or lover and the lover of lose vigor to mass. Operies of lose vigor to lose vigor to mass. Operies of lose vigor to los vigor to los vigor to lose vigor to los vigor	מרמס דר סס וררים	OON + Place Channel area.	TO-007 A-00 TIMOS	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1	re both increasing.		predominantly larger sizes.	)
deep, dense rook mass.    Adequate, Overhand Klova   Interests   Pask flow corn   Corn	rotection	and variety supposits a	9	or visor		and artil fower energies	(0)		
Margin Concress   Margin Court   M	ation	deep, dense root mass.		dense or					2/
Increases   Pask floss com- (1) rate, Middh to Depth (WD)   Depth (W	P RANKS		deep root mass.		-	liscontinuous root mass.		and shallow root mass.	
trained, VD ratio, VD rate, Vidy to Depth (VD) (Peaks, Occasional overbank (1) common, VD ratio) 25.  titled, VD ratio, VD rat		Ample for present plus some	Adequate, Overb			arely contains present			,
boolees to cook fragments of the boole fragments of th	1 Capacity	Increases, Peak flows con-	"man	6		seaks, Occasional overbank	3	common. W/D ratio >25.	4
Rocks, old logs firmly cross currents and arely unsteaded. Frequent, moder—  from and filling, Obstructions of pool filling, Chetruc, discretized by the filling of pool filling, Chetruc, defectors cause benk ero-  filted or none evident.  Infrequent raw sanks less Courrents of Courren	ock Content	65% + with large, angular boulders 12" + numerous.	Sale Baller	tly small	A	10 to 40%, with most in the	9	< 20% rock fragment oravel sizes 1=1"	00
frequent cuting or triffies stable ( ) minor poets outsets and or triffies a final consistence of filling. Obstacle of poets ( ) stable deflectors move with high ( ) sinon yearlong. Sed. traps ( ) thous cutting or triffies stable ( ) minor poets final consistence of the poets ( ) stable deflectors move with high ( ) sinon yearlong. Sed. traps ( ) this deflectors move with high ( ) sinon yearlong. Sed. traps ( ) this deflectors move with high ( ) sinon yearlong. Sed. traps ( ) this deflectors move with high ( ) sinon yearlong. Sed. traps ( ) this deflectors move with high ( ) sinon yearlong. Sed. traps ( ) this deflectors move with high ( ) sinon yearlong. Sed. traps ( ) this deflectors move with high ( ) sinon yearlong with the sed of this deflectors move with high ( ) sinon yearlong with the sed of this deflectors move with high ( ) sinon yearlong with the sed of this deflectors move with high ( ) sinon yearlong with the sed of this deflector of the sed		Rocks, old logs firmly	Some present, c	ausing		foderately frequent, moder-		Frequent obstructions and	~
Utthour cutting or   Lions and deflectors never   Water causing bank cutting   Full, channel migration   Caposition.   Came, intermittently at   Significant. Cuts 12"-24"   Abmost continuous cuts,   Little or none evident.   Came, intermittently at   Significant. Cuts 12"-24"   Abmost continuous cuts,   Little or none evident.   Came intermittently at   Significant. Cuts 12"-24"   Abmost continuous cuts,   Little or none evident.   Came new intermity at   Moder temporal continuous cuts,   Came new interess in bar   Commettion, most from   Came new interess in bar   Commettion, most from   Continuous cuts,   Came new interess in bar   Continuous cuts,   Came new interess cuts,   Came	crions	Tof pool & riffles stable				deflectors move with high	(6)	Gion year one Se. Trans	ος
Little or none evident,   Same, intermittently at   Same, intermittently at   Same, intermittently at   Same, intermittently	Sediment Trans	without cutting or				water causing bank cutting		full, channel migration	)
Infrequent raw banks less  Outcurves & constrictions,  Outcurves & constrictions,  Infrequent raw banks less  Outcurves & constrictions,  Outcurves & constrictions,  Outcurves & constrictions,  Outcurves & constrictions less  Outcurves & constrictions,  Outcurves & constrictions less  Outcurve	100	'deposition,	and less firm.			ind filling of peols,		occuring.	1
Infrequent raw banks less (G) outcurves to contrictions, (9) high, Roct mat overhangs [12] some over 24" high, Fail- thitle o'n high generally.  Law banks may be up to 12",  Cometion, most from.  Little on to enlargument  Cometion, most from.  Control of control of contr		Little or none evident.		tently at	S	ignificant, Cuts 12"-24"			1
Little or no enlargement of point bars, Commerces in bar of channel or point bars, Commerces in bar of channel or point bars, Commetton, most from of channel or point bars, Commetted bar development, plane surfaces smooth, cristiat.    Sharp edges and corners, States smooth of late, blane, or States smooth, cristiat. Commetted bar development, can be of the control of channel or states of the control of channel or states of the control of channel or change in sizes tightly. Commetted by scouring and control of commetted by scouring and comments are states of the comment of comments and where comments are deposition, comments are dependent. Comments and where comments are deposition, comments are dependent. Comments and where comments are deposition, comments are deposition, comments are deposition. Comments and where comments are deposition, comments and swifter and so comments are control of comments and swifter and so comments are control of comments and swifter and so comments. Comments are control of comments and swifter and swifter areas. Season— (3) absent, Yellow-green, short could be constituted by scouring and comments and swifter areas. Moss could be constituted by courted the constitution of channels. Could save co	ca	Infrequent raw banks less		nstrictions.	(8) (8)	ligh. Root mat overhangs	(12)		5
Sharp edges and corners, (1) Rounded corners 6 edges, (2) Corners 6 edges well round- (3) Well rounded in all dimension, plane surfaces arounded corners 6 edges, (2) Corners 6 edges well round- (3) Well rounded in all dimensions.  Sharp edges and corners, (1) Rounded corners 6 edges, (2) Corners 6 edges well round- (3) Well rounded in all dimensions attained, Cen, not "Dright", (2) Synthy dull but may have (2) Mixture, 50-50% dull and (3) Predominately bright, 55°+, and packed and/or overlapping, (2) Moderately packed with (4) Mostly a loose assortment, easily moved, ribbition No engage in sizes evident, (4) Distribution shift slight. (5) Stable materials 80-100%.  Factored Sizes tightly and or overlapping, (5) Moderate change in sizes evident, easily moved, stable materials 80-100%.  Fatherials 80-100%.  Fa	diddin dan ay in mids di na pangangan in ang didi midam in ang mananana	The state of the s	Maw Dalling Ulay	10 to 15 0	-	ווות שדנית אודוול במוחפורי		dre of overnance i requente	-
Sharp edges and corners, (1) Rounded corners & edges, (2) Corners & edges well round- (3) Well rounded in all dimensurfaces roughened, or (4) Wostly dull but may have (2) Mixture, 50-50% dull and (3) Predominately bright, 65% + (4) Surfaces amooth, (5) Wostly dull but may have (2) Mixture, 50-50% dull and (3) Predominately bright, 65% + (4) Predominately bright, 415%, 4	tion	Little or no enlargoment of channel or point bars.		from		ocerate deposition of new ravel & coarse sand on	(12)	Extensive deposits of pre- dominately fine particles.	3/
Sharp edges and corners, (1) Rounded corners 6 edges, (2) Corners 6 edges well round. (3) Well rounded in all dimensions.  Surfaces roughened, Surfaces smooth & flat. (6) Introduced to some overlaph, (7) Fredominately bright, 65% of the bottom of the bot	OM		200			And alle a cole liew Data.		עררב דב ושרפת חשו תפעב וממוובוור	-0
Surfaces smooth, et al., surfaces smooth a tist.  Surfaces dull, darkend, or U Wostly dull but may have  Stained, Cen, not "bright", arkend, or U wotly dull but may have  Stained, Cen, not "bright", arkend, or U wotly dull but may have  Responted sizes tightly, and the pocked with bright, and arkended or scoured surfaces.  Responted sizes tightly, and the properties of the bottom of the bott	ngularity	Sharp edges and corners,	(1) Rounded corners		(2)	orners & edges well round-	0	Well rounded in all dimen-	4
Stained, Gen, not "Sight", up to 35% bright surfaces.  Assorted sizes tightly  Beked and or overlapping,  Distribution not receive the series of the bottom  Distribution not receive the series of the bottom  Stable materials Stable materials S0-10%,  Assorted sizes vident,  Composition,  Abundant, Crowth largely  Common, Algal forms in low  Some filling of pools.  Abundant, Crowth largely  Common, Algal forms in low  Common, Algal forms in low  Collunt totals.  Collu	0 0 0	lorane surfaces roughened.	-	A CIBE.	~ ~	d in two dimensions.		Sions, surfaces smooth.	-
Assorted sizes tightly (2) Moderately packed with (2 Mostly a loose assortment (6) No packing evident. Loose acking packed and or overlaping, ame overlapping, ame overlapping, bistribution on the same overlapping, and or overlapping, and overlapping, and or overlapping, as overlapping, bistribution of same overlapping, and or overlapping, assortment, easily moved, assortment, easily moved, assortment, easily moved, assortment, easily moved, and or of the bottom (6) constructions and where (12 & scour at obstructions, learning, horse than 5% of the bottom (6) constructions and where (12 & scour at obstructions, line a state of flux or change) affected by scouring and (6) constructions and where (7) countrictions, and bends. (8) constructions and where (14) scour at obstructions, learning, learning, agreement, some filling of pools.  Abundant, Growth largely (7) velocity 6 pool areas, Moss (2) in backenter areas, Sesson (3) absent, Yellow-green, short (1) velocity 4 pool areas, make rocks slick, term blooms and suffer waters.	in a s	stained, Gen, not "bright",	-	t may have		inture, 50-50% dull and right, ± 15%, 1e 35-65%.		Predominately bright, 65% +	
Distribution No change in sizes evident, (4) Distribution shift slight, (5) Siderate change in sizes. (12) Marked distribution change, sable Materials S0-307, (5) Stable materials 20-507, (5) Stable materials 20-507, (5) Stable materials 20-507, (6) Stable materials 20-507, (7) Stable materials 20-507, (8) Stable materials 20-507, (9) Stable materials 20-507, (9) Stable materials 20-507, (9) Stable materials 20-507, (9) Stable materials 20-507, (10) Stable materials 20-507, (10) Stable materials 20-507, (10) More than 507 of the bottom at size of flux or change. (10) Stable materials 20-507, (10) St	idation or	Assorted sizes tightly	-		-	tostly a loose assortment	(9)	No packing evident, Loose	0
bistribution No change in sizes evident, (4) Distribution shift slight, (5) Stable materials 20-507, Stable materials 90-107, Stable 90-107, Stable materials 90-107, Stable materials 90-107, Stable 90-107, Stable materials 90-107, Stable materials 90-107, Stable 90-107, Stable materials 90-107, Stable 90-107, Stabl	icle Packing	packed and/or overlapping.	some overlappin		-	Ath no apparent overlap.		assortment, easily moved.	0
Less than 5% of the bottom (5-30% affected, Scour at 10-50% affected, Deposits (Nore than 50% of the bottom (5-30% affected, Deposits).  Less than 5% of the bottom (5-30% affected, Scour at 10-50% affected, Deposits (10 n a state of flux or change).  Less than 5% of the bottom (5-30% affected, Scour at 10-50% affected, Deposits (10 n a state of flux or change).  Less than 5% of the bottom change (10 constrictions, and bends).  Less than 5% of the bottom change (10 constrictions, and bends).  Less than 5% of the bottom change (10 constrictions, and bends).  Less than 5% of the bottom change (10 constrictions, and bends).  Less than 5% of the bottom change (11 n a state of flux or change).  Less than 5% of the bottom change (11 n a state of flux or change).  Less than 5% of the bottom change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom or change (11 n a state of flux or change).  Less than 5% of the bottom	n Size Distribution	No change in sizes evident.	===	nift slight.	E	oderate change in sizes.	(12)	Marked distribution change.	7/
affected by scouring and (6) constrictions and where (12) 6 scour at obstructions, (18) in a state of flux or change.  Some filling of pools.  Abundant, Growth largely  Common, Algal forms in low Present but spotty, mostly  Peresent bloom save by present.	cent Stable Materials	Tess than \$7 of the hotten	Stable material	\$50-80%	3	Cable materials 20-50%.		Stable materials 0-20%.	,
deposition.  Abundant, Growth largely  Common, Algal forms in low  Present but spotty, mostly  Present but spotty, mostly  Perental types scarce or  Common, Algal forms in low  Present but spotty, mostly  Perental types scarce or  Present but spotty, mostly  Perental types scarce or  Algae;  Common, Algal forms in low  Present but spotty, mostly  Perental types scarce or  Algae;  Common and but spotty, mostly  Perental types scarce or  Algae;  Collunt polals  Collunt polals	ing and		- · · ·	,	-	Scour at obstructions.	(18)	in a state of flux or change	Lak
Abundant, Growth largely  Common, Algal forms in low Present but spotty, mostly  Common, Algal forms in low Present but spotty, mostly  Common, Algal forms in low Present but spotty, mostly  Common, Algal forms in low Present but spotty  Common, Algal forms and forms and forms and forms spotty  Collow Form of the for	Deposition		24.60		-	constrictions, and bends.		nearly yearlong.	77
Abundant, Growth largely Common. Algal forms in low Present but spotty, mostly Perennial types scarce or Collow Forth largely Collow Fo			deposition in p	pools.	2	ome filling of pools.			- 1
constant and street, per (I) velocity & pool srees, floss (Z) in backwater areas, Season (3) absent, fellow-green, short contals, in swift bloom say be present.  COLUMN TOTALS: - 19	ing Aquatic	Abundant, Growth largely	Common. Algal	forms in low	6	resent but spotty, mostly		Perennial types scarce or	4
COLUMN TOTALS 14	(oss & Algae)		here too and au	of fror carers	3	n Deckyster areas, yeason-	3	absent, Yellow-green, snort	
		COLUMN TOTALS	0	•			0	-	11

Reach score of: <38-Excellent, 39-76 "Good, 77-114" Fair, 1154-Poor.

+



Upper Basin 8/16/76

1

Iten Rated		Stability Inc	Staullity Indicators by Classes	
I. UPPER BANKS	EXCELLENT	0000	FAIR	POOR
Landform Slope	Bank slope gradient <30%	(2) Bank slope gradient 30-40%	(4) Bank slope gradient 40-607,	(6) Bank slope gradient 60% + 18
	No evidence of past or	Infrequent and/or very small,	1-	Frequent or large, causing
(Existing or Potential)	potential for future mass	(3) "Mostly healed over, Low	(6) with some raw spots eroded the water during high floor	(9) sediment nearly yearlong OR /Z
Debris Jam Potential	Tresportially about from	(2) Present but most a small	Drangary wolling and elec	
(Floatable Objects)	Immediate channel area.	twigs and limbs.		_
Bank Protection	190% + plant density. Vigor	70-90% density. Fewer plant	50-70% density, Lower vigor	< 50% density plus fewer
from	and variety suggests a	(3) species or lower vigor	(6) and still fewer species	(9) species 6 less vigor indi-
Vegetation	deep, dense root mass.	suggests a less dense or	form a somewhat shallow and	-
II. LOWER BANKS		יבכה וומססס	מייים בייים ביים בייים בייים בייים בייים בייים בייים בייים בייים בייים ב	ALIC URBLACK COC MASS
Channel Capacity	Ample for present plus some increases, Peak flows con-	(1) rare. Width to Depth (W/D)	Barely contains present	Inadequate. Overbank flows 4
	tained, W/D ratio <7.	ratio 8-15,	floods, W/D ratio 15-25,	
Bank Rock Content	65% + with large, angular boulders 12" + numerous,	(2) 40 to 65%, mostly small boulders to cobble 6-12".	(4) 20 to 40%, with most in the (3-6" diameter class.	6 < 20% rock fragments of gravel sizes, 1-3" or less.
	Rocks, old logs firmly	Some present, causing	Moderately frequent, moder-	ructio
Obstructions	embedded, Flow pattern	erosive cross currents and	(	deflectors cause bank ero-
Flow Deflectors			3	(6) Sion yearlong. Sed. traps 10
Sediment Traps	deposition.	and less firm	water causing bank cutting	full, channel migration
	Little or none evident.	Some, intermittently at	Significant, Cuts 12"-24"	Almost continuous cuts.
Cutting	Infrequent raw banks less	(4) outcurves & constrictions.	28s	(12) some over 24" high, Fail- 16.
	"than 6" high generally,	Raw banks may be up to 12",	[7] and sloughing evident.	' fure of overhangs freduent,
	Little or no enlargoment		"Aderate deposition of new	
Deposition	of channel or point bars.	(4) formation, most from		dominately fine particles. /6
I. BOTTOM		coarse gravels.	rold and some new bars.	A Accelerated bar development,
Rock Angularity	Sharp edges and corners.	(1) Rounded corners & edges.	(2) Corners & edges well round-	(3) Well rounded in all dimen-
	plane surfaces roughened.	surfaces smooth	ed in two dimensions.	sions, surfaces mooth,
Brightness	Surfaces dull, darkened, or stained, Gen. not "bright".	(1) Mostly dull but may have	(2) Mixture, 50-50% dull and hright + 15% 10 35-65%	Predominately bright, 65. +.
Consolidation or	Assorted sizes tightly	(2) Moderately packed with		k٠.
Particle Packing	packed and or overlapping.	diam'r.	with no apparent overlap.	-
Sottom Size Distribution	No change in size	(4) Distribution shift slight.	S.	Se.
& Percent Stable Materials	Stable materials	Stable materials 50-80%,		-
	Less than 5% of the bottom		30-50% affected. Deposits	E-1-7
scouring and	affected by acouring and	(6) constrictions and where		18) in a state of flux or change 24
Deposicion	deposition.	grades steepen. Some	Some filling of pools.	13 nearly yearlong.
Clinging Aquatic	Abundant. Growth largely		Present but spotty, mostly	Perennial types scarce or
Vegetation	green,	(1) velocity 6 pool areas. Moss	(2) in backwater areas. Season-	(3) absent, Yellow-green, short
CHOSE & ALRES	contact, in swift vater too.	here too and swifter waters.	al blooms make rocks slick.	term bloom may be present.
			6	98
		211	- 11	

Add the values in each column for a total reach score here. (E. 4 + G. 22 + F. 48 + P. - - 74).

Reach score of: <38-Excellent, 39-76-Good, 77-114- Fair, 115--Poor.



in a state of flux or change 24

nearly yearlong.

30

More than 50% of the bottom

(3) absent, Yellow-green, short

(2) in backwater areas. Season-

Some filling of pools.

al blooms make rocks slick

here too and swifter waters.

(1) velocity & pool areas. Moss

Abundant. Growth largely moss like, dark green, per-

Vegetation

linging Aquatic

(Moss & Algee)

ennial, In swift water too

Cormon. Algal forms in low

grades steepen. Some deposition in pools. term bloom may be present.

Marked distribution change.

(O)

(8) Noderate change in sizes.

(4) Distribution shift slight.

No change in sizes evident,

Particle Packing Bottom Size Distribution & Percent Stable Materials

packed and or overlapping.

Assorted sizes tightly

Stable materials 80-1007. Less than 5% of the bottom

affected by scouring and

deposition.

Deposition

Scouring and

5-30% affected. Scour at

Stable materials 50-80%, (6) constrictions and where

with no apparent overlap.

Stable materials 20-507. constrictions, and bends.

& scour at obstructions,

12)

assortment, easily moved. Stable materials 0-207.

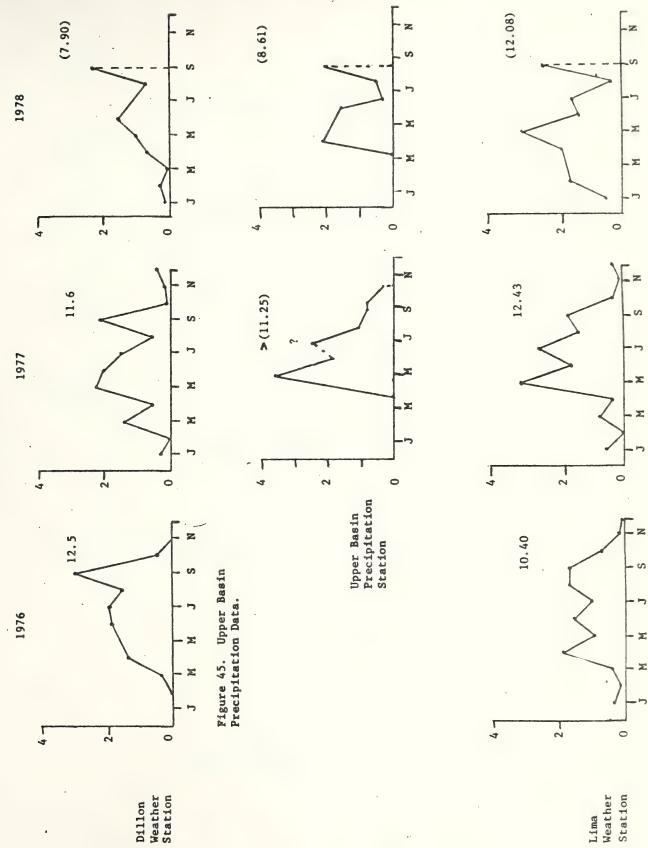
Little Basin

8/16/76

00 (9) sediment nearly yearlong OR 1/2 4 00 (3) Predominately bright, 657. + gravel sizes, 1-3" or less, Accelerated bar development, exposed or scoured surfaces, species & less vigor indi-Inadequate, Overbank flows common, W/D ratio >25. Extensive deposits of pre-(12) dominately fine particles. (3) Well rounded in all dimen-Moderate to heavy amounts, deflectors cause bank ero-Frequent or large, causing predominantly larger sizes Bank slope gradient 60% + some over 24" high, Failure of overhangs frequent, (6) No packing evident. Loose sion yearlong. Sed. traps cate poor, discontinuous, Frequent obstructions and < 50% density plus fewer mminent danger of same full, channel migration < 20% rock fragments of Almost continuous cuts and shallow root mass. POOR occuring. 9 9 (9) 6 3 (9) 12) (4) 20 to 40%, with most in the (4) & deflectors move with high vater causing bank cutting 50-70% density, Lower vigor (6) and still fewer species form a somewhat shallow and Corners & edges well roundately unstable obstructions Moderately frequent, moder-(4) Bank slope gradient 40-607, by water during high flows. peaks, Occasional overbank Noderate deposition of new gravel & coarse sand on sold and some new bars. Moderate frequency & size, (6) with some raw spots eroded (4) Mostly a loose assorbaent Significant, Cuts 12"-24" high, Root mat overhangs Present, volume and size bright, ± 15%, 1e 35-65%. (2) Mixture, 50-50% dull and floods, W/D ratio 15-25, discontinuous root mass Barely contains present ed in two dimensions. and filling of pools 3-6" digneter class, S are both increasing Stability Indicators by Classes 0 3 Infrequent and/or very small, minor pool filling, Obstruc-70-90% density. Fewer plant Bank slope gradient 30-40% tions and deflectors newer erosive cross currents and (1) rare. Width to Depth (W/D) outcurves & constrictions. Raw banks may be up to 12" up to 35% bright surfaces suggests a less dense or (2) Present but mostly small Mostly healed over, Low boulders to cobble 6-12" Rounded corners & edges, surfaces smooth & flat. Mostly dull but may have Some, intermittently at Some new increas in bar (2) 40 to 65%, mostly small (3) species or lower vigor (2) Moderately packed with Some present, causing (4) formation, most from future potential twigs and limbs. deep root mass. coarse gravels. and less firm, ratio 8-15. 3 3  $\Xi$ 3 Plane surfaces roughened. Surfaces dull, darkened, or Ample for present plus some stained, Gen, not 'bright", increases. Peak flows con-902 + plant density, Vigor potential for future mass 65% + with large, angular Infrequent raw banks less of channel or point bars. Little or no enlargument of pool & riffles stable Sharp edges and corners, coulders 12" + numerous. than 6" high generally. Essentially absent from Little or none evident. immediate channel area. and variety suggests a No evidence of past or deep, dense root mass. Rocks, old logs firmly embedded. Flow pattern wasting into channels. tained, W/D ratio <7, Bank slope gradient without cutting or deposition. (Existing or Potential) (Floatable Objects) Debris Jam Potential Sediment Traps Flow Deflectors Bank Rock Content Item Rated Channel Capacity onsolidation or Rock Angularity lenk Protection andform Slope LOWER BANKS lass Wasting Vegetation Obstructions IPPER RANKS Deposition rightness utting

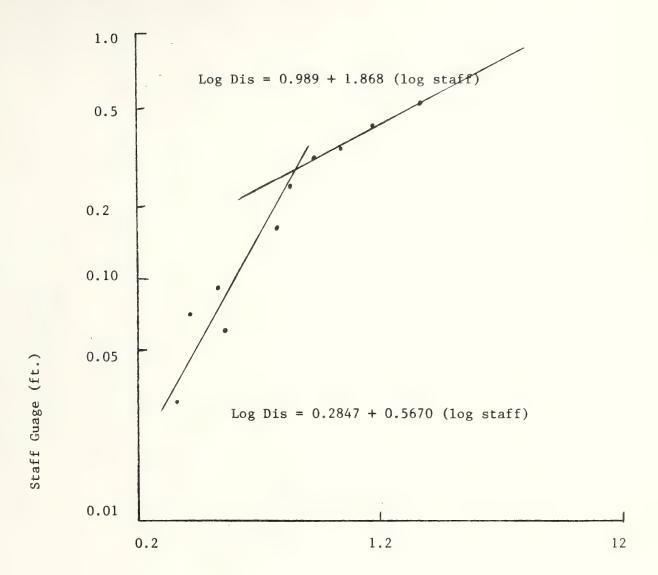
Add the values in each column for a total reach score here. (E. 7 + G. 26+ p. 34 + P. - 67)





Lima Weather Station

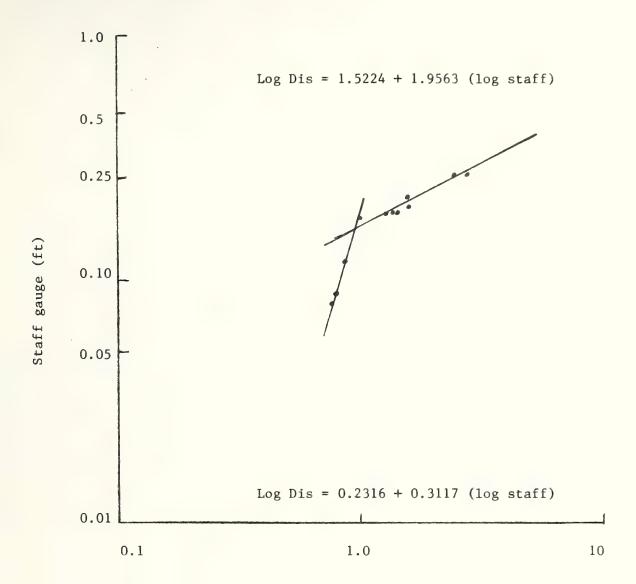




Stream Discharge (cfs)

Figure 46. Staff-discharge Rating Curve for Lower Basin Sampling Station.

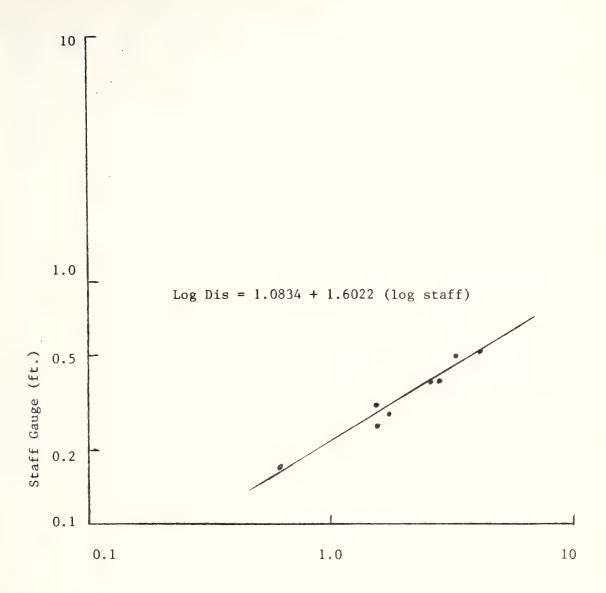




Stream Discharge (cfs)

Figure 47. Staff-discharge Rating Curve for Upper Basin Sampling Station.





Stream Discharge (cfs)

Figure 48. Staff-discharge Rating Curve for Little Basin Sampling Station.



104 135.0000 0.0000 120.0000 105.0000 75.0000 0000.09 150.0000 9000-26 45.0000 30.0000 15.0000 SEP 30 . AUG (15) FIGURE 49. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS LUWER BASIN - 1977 . APR \* FER DEC 0CT 1 10.0000+ 0.000.4\* 1.0000+ 9. Cuou+ 8.0000+ 2.000+ 6.00Cü+ 5.00004 4.00034 3.0000 

L



FIGURE 50. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS



106 70.0000 0000.09 20.000 33.3000 20.0000 100.000 96. 4000 80.0000 40.0000 10.0000 6.3000 SEP 30 : AUG : JUN : PICURE SI. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS UPPER BASIN - 1977 (11) : APR : PEB DEC T LOO 3.0001+ 10.000. +0000° 5.03004 9.0000 7.00064 3.50000 2.000+ 1.000.1 6.0.0.0 4.0000+ 





FIGURE 53. ANNUAL HYDRIGRAPH AND SEDIMENT LOADINGS

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THE STREET



109 94.0000 66.3000 0.000.0 100.0000 70.000 50.0000 40.0000 30.0000 20.0000 10.0000 86.0000 SEP 30 3 VAG . JUN : LITTLE BASIN - 1978 : APR · FEB · DEC ₩ # # 27 \*+0000"0 10.0001 9°6060+ 7.000+ <.0000+ 4.0002 4.0000+ 6. COPO+ \*.000. 8.000.4 1.000.1 

FIGURE 54, ANNUAL HYDRIGRAPH AND SFDIWENT LOADINGS



in mid-May. The lowest recorded flow for 1978 was 0.26 cfs in mid-April. The Upper Basin station exhibited somewhat similar patterns. Residual channel ice may also have influenced an estimated peak dishcarge of 11 cfs in mid-April, 1977. The lowest recorded flow for the year was 0.88 cfs in mid-July. In 1978 an annual peak flow of 7.0 cfs was estimated for mid- to late May, while the lowest flow was recorded at 0.80 cfs in mid-July. Peak flow apparently occurred in mid-April, 1977 in Little Basin. Again, residual channel may have influenced the estimated 5.0 cfs crest stage figure. A secondary peak was noted for late May, while low flow for the year was 0.71 cfs in mid-July. An estimated 9.9 cfs peak occurred in early May, 1978, but was preceeded by the annual low flow of 1.3 cfs in mid-April. The differences noted in flow patterns for the two hydrologic years are largely attributed to differences in the annual precipitation patterns and to the influence of basin topography.

The respective annual hydrograph data were used to estimate the annual water yields for each station (Table 19). The Lower and Upper Basin stations approximated 1,000 acre feet each year, while Little Basin averaged nearly 1,500 acre feet. These estimates confirm general field observations. The reduced water yield for Lower Basin is attributed to evapotranspirational stress in and along the watercourse and to subsurface seepage of channel flow in the nearly flat terrain. In one instance a segment of Basin Creek above the Lower station was found dry. Absolute differences between the hydrologic years are difficult to determine owing to the high percentage of water yield that must be estimated for the winter months.

## Suspended Sediment

The annual patterns of sediment concentration for each station by hydrologic year are depicted in Figures 49-54. Suspended sediment con-

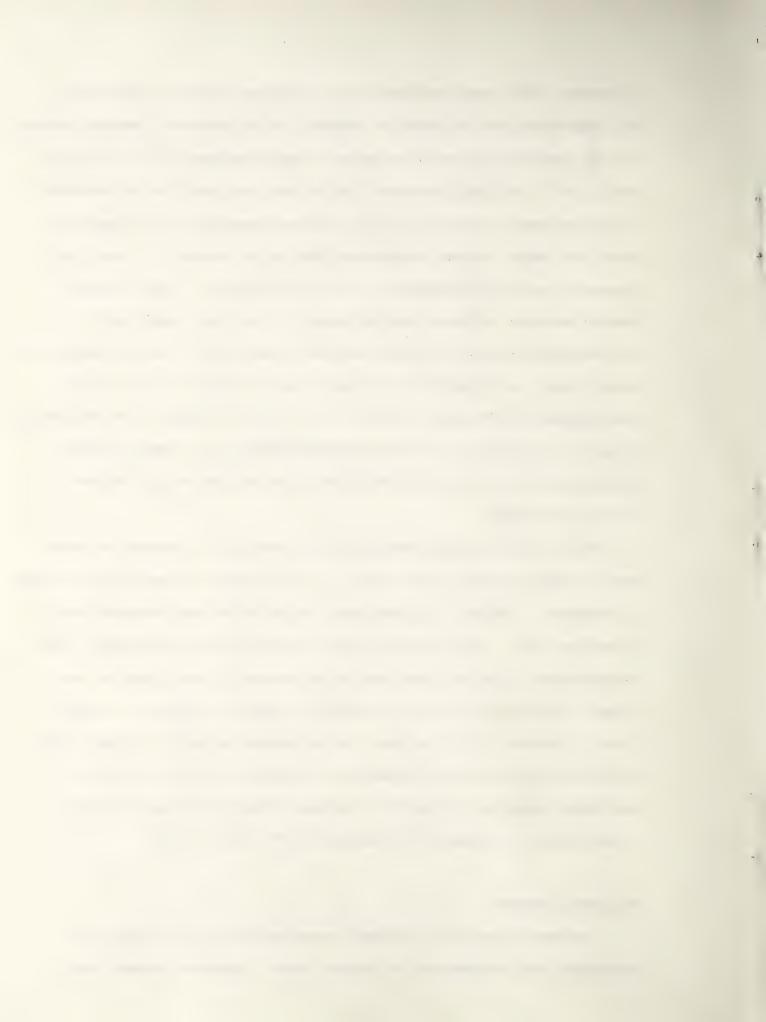


Table 19. Estimated Water and Sediment Yields for Little Sage and Basin Sample Watersheds, 1977-1978

33	Water	Estimated	Estimated	Contributing	Runoff	Sediment
*	Year	Water Yield (ac ft.)	Sediment Yield (tons)	Watershed (acres)	(in. / ac.)	Yield (lbs. / acre)
7	1977	780	. 31	14,720	0.64	4.19
-	1978	780	21	14,720	99.0	2.85
		-				
	1977	1,150	61	32,960	0.42	3.70
-	8261	068	33	32,960	0.32	2.00
7	1977	046	15	6,720	1.68	4.34
7	1978	950	33	6,720	1.70	9.71
					;	
-	1977	1,270	15	11,840	1.29	2.59
1	1978	1,610	35	11,840	1.63	5.99

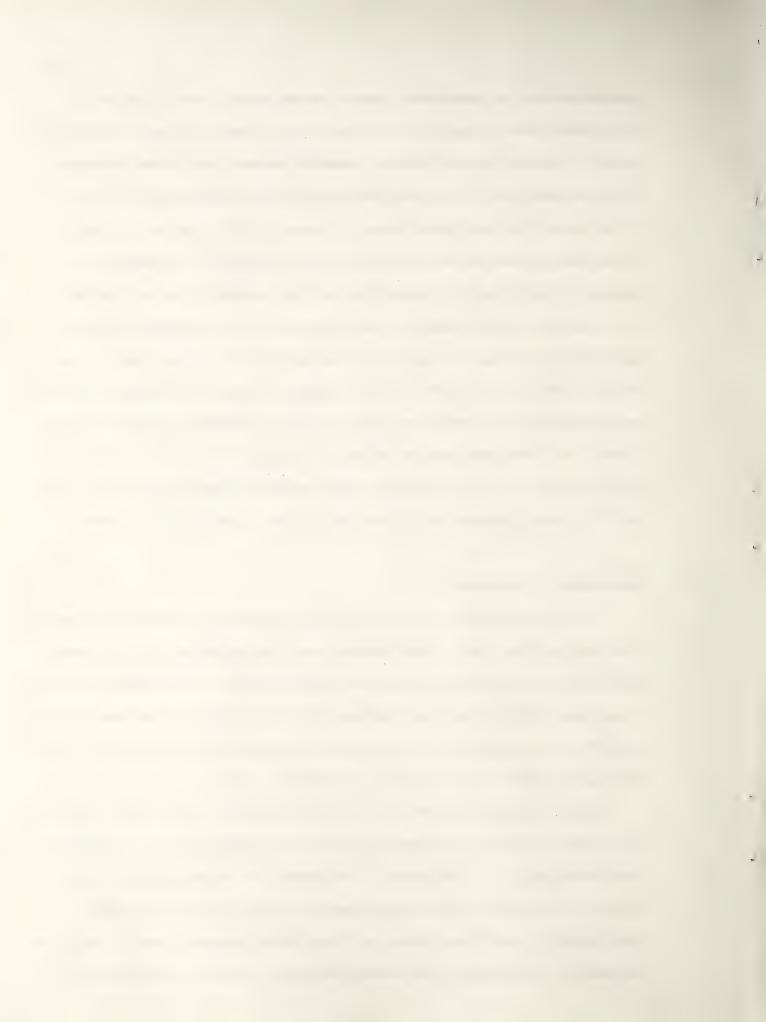


centrations at the Lower Basin station ranged from <5 ppm to 146 ppm, at Upper Basin from <5 ppm to 63 ppm, and from <5 ppm to 38 ppm for Little Basin. The relationships between suspended sediment and stream discharge for Lower Basin and Little Basin were statistically significant, but the relationship for Upper Basin was not (Figures 55-57). The variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effects, the presence of cattle, and to the hysteresis effect, whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973, pp. 215-219). Annual sediment yields for the Basin stations were estimated from respective water yield and sediment concentration data (Table 19). The Lower station indicated a yield of 61 tons for 1977, but only 33 tons for 1978. Both Upper Basin and Little Basin generated 15 tons in 1977, which increased to 33 tons and 35 tons respectively for 1978.

## Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lower concentrations occur during periods of high runoff, while higher concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Walling, 1973, pp. 219-225). Patterns for specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et al., 1977, pp. 74-76).

Specific conductance for the Lower Basin station ranged from a low of 272 µmhos to a high of 478 µmhos, Upper Basin from 242 µmhos to 363 µmhos, and Little Basin from 300 µmhos to 504 µmhos. The relationships between specific conductance and stream discharge for the Basin stations were statistically significant except for Upper Basin (Figures 58-60). Variation in specific conductance with stream discharge is partially attributed to



PASIN	
LOWER	
DISCHARGE	
Σ	
VS STREAM	
VS	
SEDIMENT	
SUSPENDED	
FIGURE 55.	
Page 1	

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STREAM DISCHARGE :CFS:

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FIGURE 56. SUSPENDED SEDIMENT VS STREAM DISCHARGE - UPPER DASIN

С



STREAM DISCHARGE : CFS:

	FIGURE 57.		SUSPENDED SEDIMENT VS STREAM DISCHARGE LOG SED = 0.9327 + 0.6177(LOG DIS)	ENT VS STR.	SAM DISCHAF		LITTLE BASIN				
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1462• -2246• -0000•	278,0778										
.2246+	249.1462+		1	w a common w		!					
****	223.2246+			The second secon					;	· · · · · · · · · · · · · · · · · · ·	110
	200.0000						•			* ** ** **	5

FIGURE 58. CONDUCTIVITY VS STREAM DISCHARGE - LOWER BASIN

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+



	600.0000+	
481.6449+ AAA AAA 431.5338+ AA 431.5338+ AA 346.0.00+ 346.4102+ 346.4102+ 279.0.778+ 249.146.+	537,5751	
431.5336+ A. 431.5336+ A. 346.6102+ 346.4102+ 278.0778+ 249.146.+	481.6449+ AA	AA AA AA
346.0364 346.4102 310.3094 279.0778 249.1464	431.5338+	AAA
345.4102. 310.309. 279.0778. 249.146.	386.0.0	
	345.4102+	AAA AAA AAAA AAAA AAAA AAAAA AAAAA AAAAA
279.0778+ 249.146.+ 223.2245+	310.3094	AAAA AAAA
249.14624 2 AAA AAA 223.2245		AA
223.2245.	249.146.+	AAA AAA AAA AAA AAA AAA AAAA AAAA AAAA AAAA
	223.2245+	AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
200,0000	200° 0000	

FIGURE 59.. CONDUCTIVITY VS STREAM DISCHARGE - UPPER BASIN



118 10.01 346.0 000.000+ 3.904 7.542 0.34 1.045 1.045 STREAM DISCHARGE :CFS: 102.0 0.158 200.0333+ 537.5751+ 278.0778+ 401.0445+ 431.5338+ 249-1462+ 223.2246+ 396.6364 346.4102 310.309

FIGURE 60. CONDUCTIVITY VS STREAM DISCHARGE - LITTLE BASIN.



seasonal, and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225) and to the influence of topography. The ranges in ionic concentration for specific ions are presented in Table 20.

## Bacteria Levels

The concentration of fecal and total coliforms in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising stage (Kunkle and Meiman, 1978), with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their own "flushing" effect, and which may or may not be followed by a short term dilution period.

The concentrations of fecal coliform for the Basin Creek stations for the study period are presented in Table 21. Higher values occurred during the grazing season, especially with the known presence of livestock. Maximum fecal coliform levels were 490, 1,590 and 106 colonies/100 mls respectively for each station. Twenty-five percent each of the sample coliform counts for Lower and Upper Basin exceeded the 200 colony/100 ml limit of the Montana Water Quality Criteria. Little Basin had no exceptions. Low values were associated with the spring season.

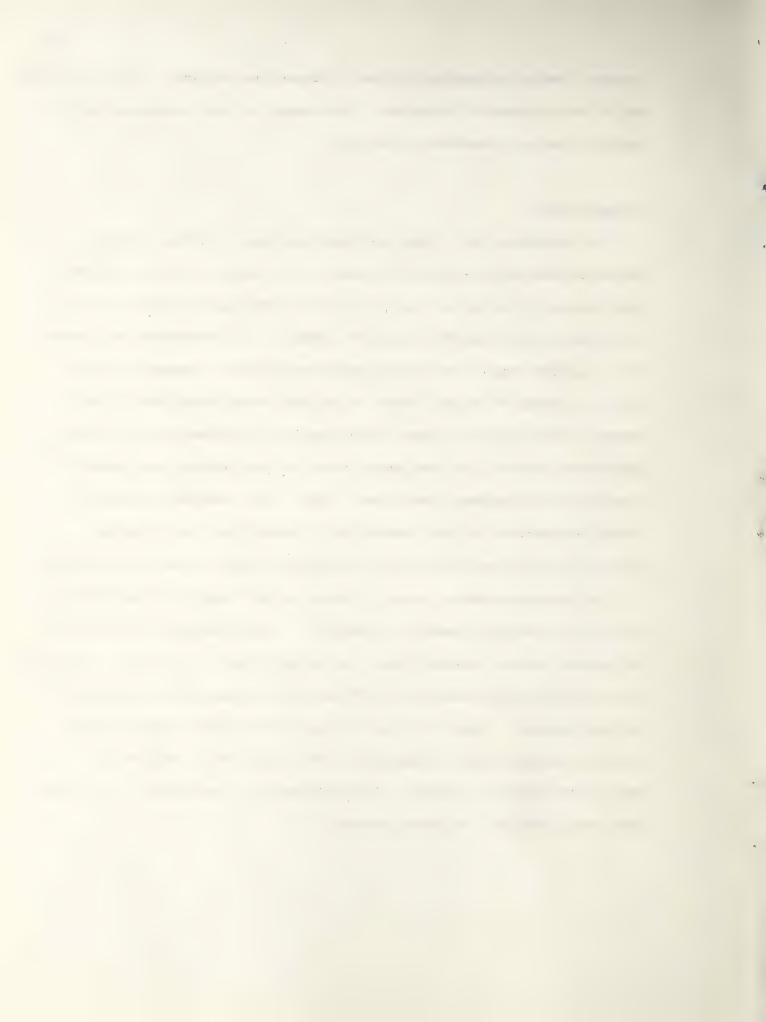


Table 20 Ranges in Hydrochemical Parameters for Basin Creek, 1977 - 1978.

	Lower Basin	Upper Basin	Little Basin
pH Alkalinity (CaCO <sub>3</sub> )(mg/1)	7.89 - 8.87 139 - 217	7.69 - 8.21 134 - 185	
Specific Conductance (umhos) Total Dissolved Solids (mg/1)	272 - 478 177 - 311	242 - 363 157 - 236	300 - 504 183 - 328
Ca (mg/1) Mg (mg/1) Na (mg/1) K (mg/1) HCO (mg/1) SO 4		35 - 63 4.5 - 7.8 3.6 - 7.0 2.0 - 4.3 164 - 226 2 - 7	41 - 63 11 - 21 5.3 - 15 .96 - 2.6 172 - 281 8 - 34
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	∠.0131	∠.0108 ∠.01 - (.19) .004 - (.139)	<.0109



Table 21 Fecal Coliform Counts (colonies/100 mls) for Basin Creek, 1977 - 1978.

	Lower Basin	Upper Basin	Little Basin
	1977 1978	1977 1978	1977 1978
April			
May	<b>&lt;</b> 1 <b>&lt;</b> 2	<b>&lt;</b> 1 1	<2
June	7(?) 20	4(?) 2	2(?) 6
July	120(?) 27	83(?) 161(?)	2(?) 106(?)
August	24* 15(?)	245(?) 1260*	7(?) 30(?)
September	490* 307(?)	22(?) 1590*	6(?) 43(?)
October ·	230*	68*	2(?)
November	8*	25(?)	<b>&lt;</b> 2(?)

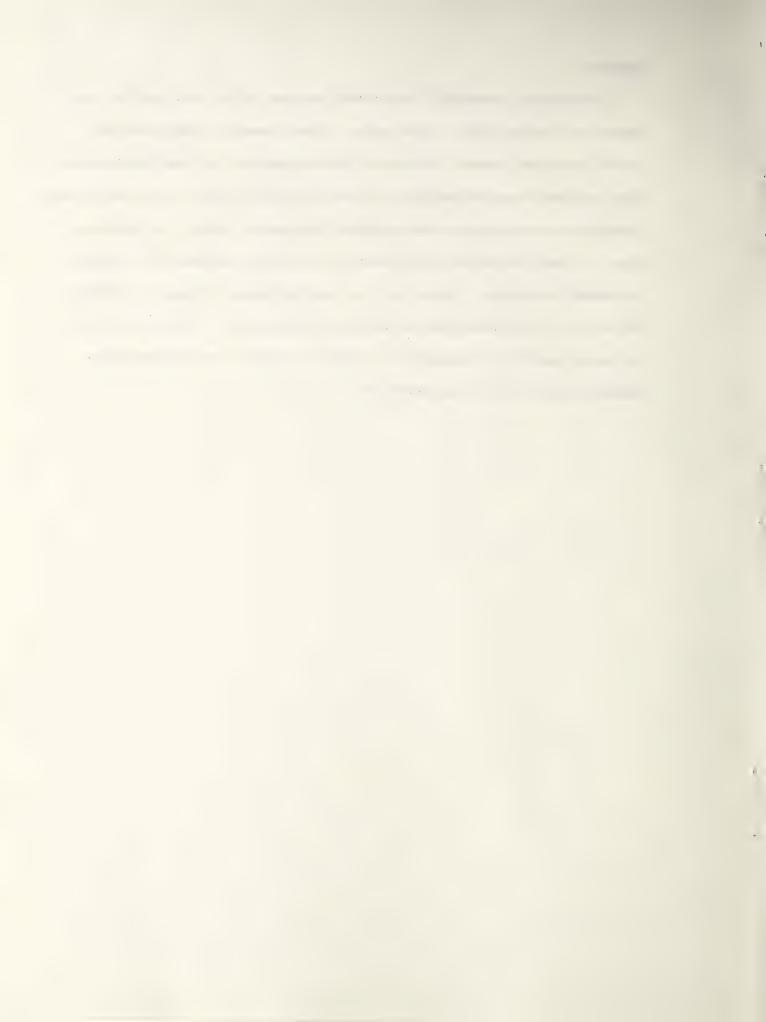
<sup>\*</sup> Stock visually present.

<sup>(?)</sup> Stock presence uncertain.



## Comments

Basin Creek, especially the middle portion, is a very gentle, high elevation, dryland basin. This suite of environmental conditions may retard the normal annual flushing effect encountered in other environments. Thus, neither suspended sediment concentration nor conductivity was strongly correlated with stream discharge within the general basin. In addition, there is some indication that livestock influenced sediment concentrations on several occasions. Because of the limited number of samples taken and the nature of the hydrochemical parameters evaluated. relationships between the water quality characteristics of Basin Creek and the Montana Water Quality Criteria cannot be addressed.

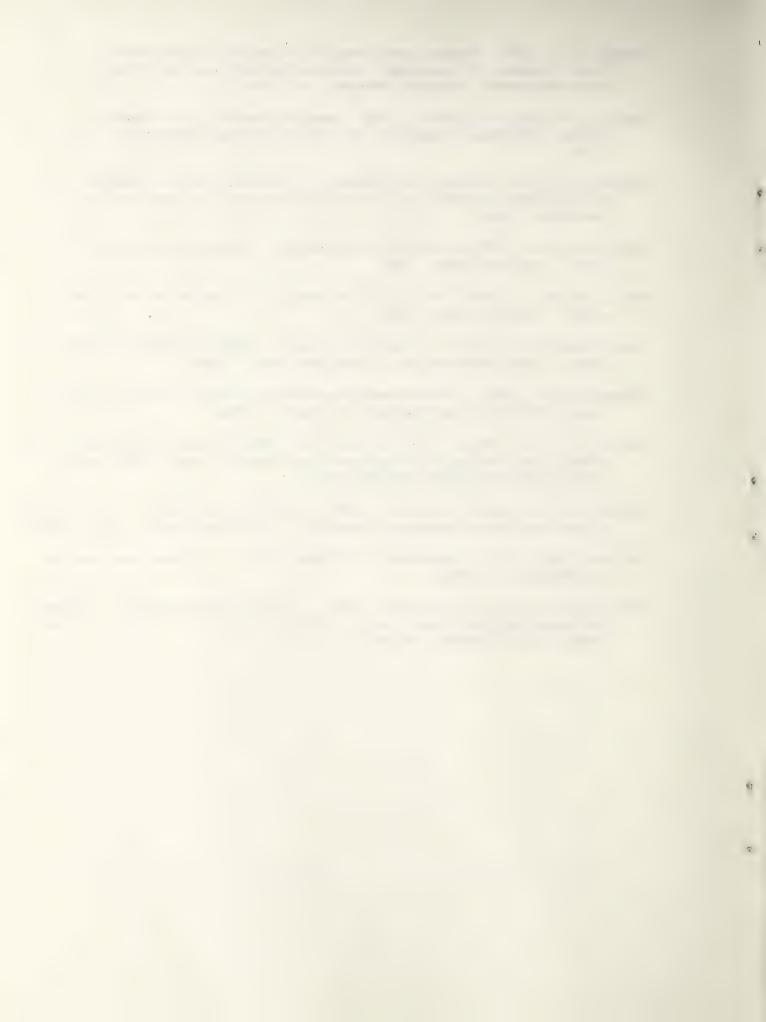


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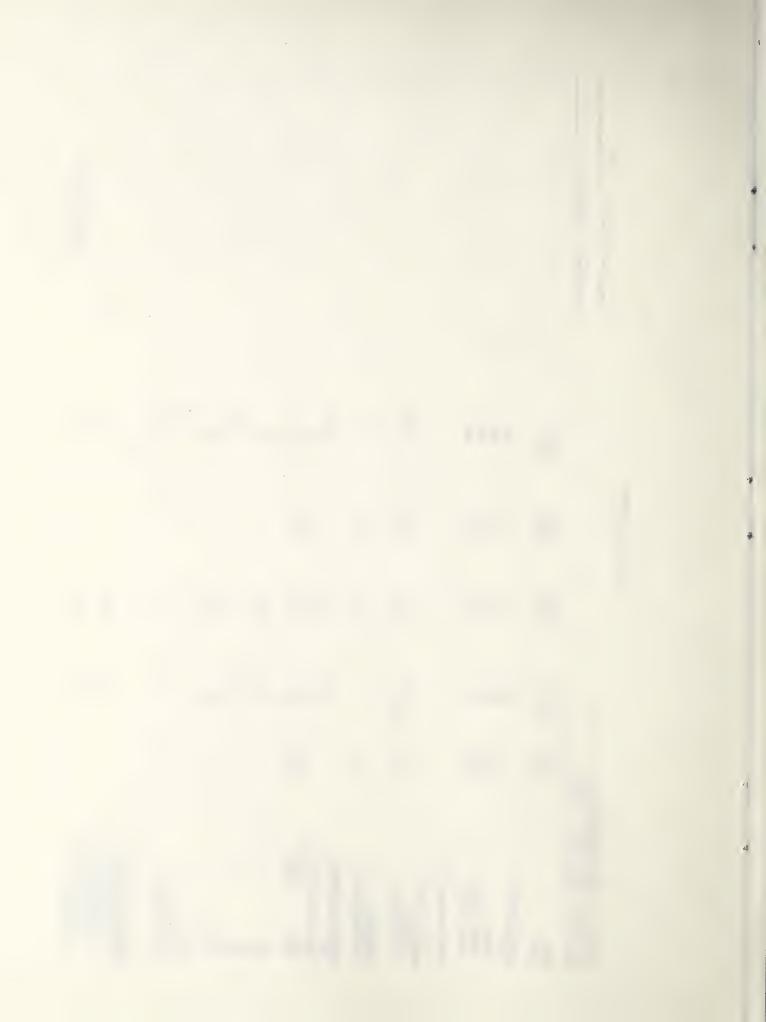
Station: Lower Blacktail Location: S 28 T 11S R 5W	3						Sco	re: 65	
1977	1074			1977			Survey Date:	8/15/76	
Date Time	9/23	10/25	11/20	5/2 1215	5/12 1230	5/19	5/31 1200	6/13 1230	6/25 1130
Temperature (F°) air water water (max) water (min)	inst	36 34 34	36	50 44 inst inst	61 47 36	797 797 377	64 45 10st 10st	57 45 inst inst	70 50 lost lost
Precipitation (in)			u.						
Discharge (cfs) instant crest stage	54	21	61	29 set	25	28	388	195* <b>3</b> 195	76 220
Suspended sediment (ppm)	•	14	28	12	31	21	16	117	29
Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)		363 235	362 235	8.13 130 274 178	328	333 216	8.14 160 335 218	272	7.95 156 321 209
Ca " Legend:	gend: set - Initial settings of set - Installation of pi inst - Installation of pi I - Trace or Trickle Moved - Station was move () - Value questionable () - Volue questionable u - Unknown y - yes n - no ice - Station was iced sice - Station was iced sice of station was iced sice of the set of station was inced sice of station was iced sice of	gend: set - Initial settings of instrument inst - Installation of ppt gages I - Trace or Trickle Moved - Station was moved to a beter () - Value questionable INTC - Too numerous to count u - Unknown y - yes n - no ice - Station was iced so that sample	gend:  set - Initial settings of instrument 10  inst - Installation of ppt gages 3.0  I - Trace or Trickle 1.1  Moved - Station was moved to a beter location 159  () - Value questionable 21  TNTC - Too numerous to count 21  U - Unknown 21  Ny - yes 21  n - no 1ce - Station was iced so that sample variable was not obtainable 32	43 10 3.0 1.1 159 21   	sinable		49 12 3.7 0.97 195 23   		47 11 3.2 0.78 190 17 .17 .005

\*Staff dislodged



	Stream Reach Score: 65 Survey Date: 8/15/76								* Staff dislodged ** Staff moved
		9/30 1315	36 38 36	18,44	13	8.10 151 303 197	56 16 4.8 1.1 184	.06 .11 .013	7 80 E
BASIC DATA RECORD		9/22	41 42 37	24	۲۶	330 214			*
BASI		8/32 1145	54 58 58 50 50 50 50 50 50 50 50 50 50 50 50 50	27 30	10	8.13 163 313 203	54 15 4.5 199 28	.01 .17	30 40 y
		7/29 1315	68 54 41	30* 32*	'n	8.22 161 308 200	48 13 3.8 0.86 196 24	.03	54 51
	SW.	7/13	59 51 inst	32 76	15	298			a
	Station: Lower Blacktail Location: S 28 T 11S R Water Year: 1977	Date Time	Temperature (F°) air water water (max) water (min)	Discharge (cfs) Instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	Ca Mg Na K K HCO	NH, NO 6 NO -N '' PO 2 (Ortho) -P ''	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present

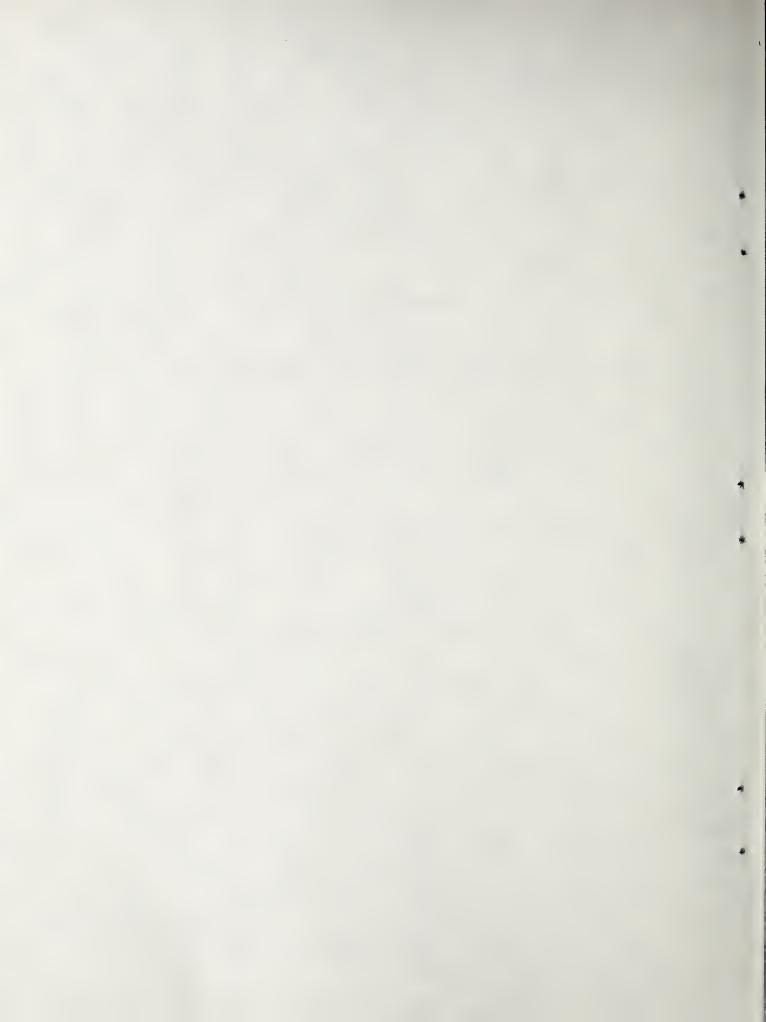
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	6/28	78	117	38	316 205		.01 .02 .030		
Stream Reach Score: 65 Survey Date: 8/15/76	6/20	62 4	168	797	8.09 131 272 177	41 9.7 3.1 0.72 158	0.00	240	< 2
Stream Reach Survey Date:	6/16 1315	0 4 4 4 0 7 4 4	214	69	261 170				
	6/9	59 47 47 40	938	938	208 135				
	6/4	66 49 inst	166	91	283				-
	5/31	37	83	98 31	00 295 192	<b>3</b> E	.02 .02 .019		
	1978 5/24 1730	37	86	set 97	8.10 8.00 7,7 145 22 277 33 180		.15	275	2
	11/12	34 36 46 32	12	57	14	48 14 3.9 95 0.81 25	.09 .055 T	10	2
MS.	1977 10/18 1300	64 41 47 32	112	18	8.10 165 329 214	52 16 4.4 0.95 202 26		115	4
Station: Lower Blacktail Location: S 28 T 11S R Water Year: 1978	Date Time	Temperature (F°) air water water (max) water (min)	Precipitation (in) Discharge (cfs) instant	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	Ca M8 Na NCO HCO	NH, NO, 6 NO -N " PO, (Ortho)-P "	Biological Character Total Coliform (colonies/100 mls)	(colonies/100 mls)

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BASIC DATA RECORD



1040

927

Biological Character
Total Coliform
(colonies/100 mls)
Fecal Coliform
(colonies/100 mls)
Stock present

27 y

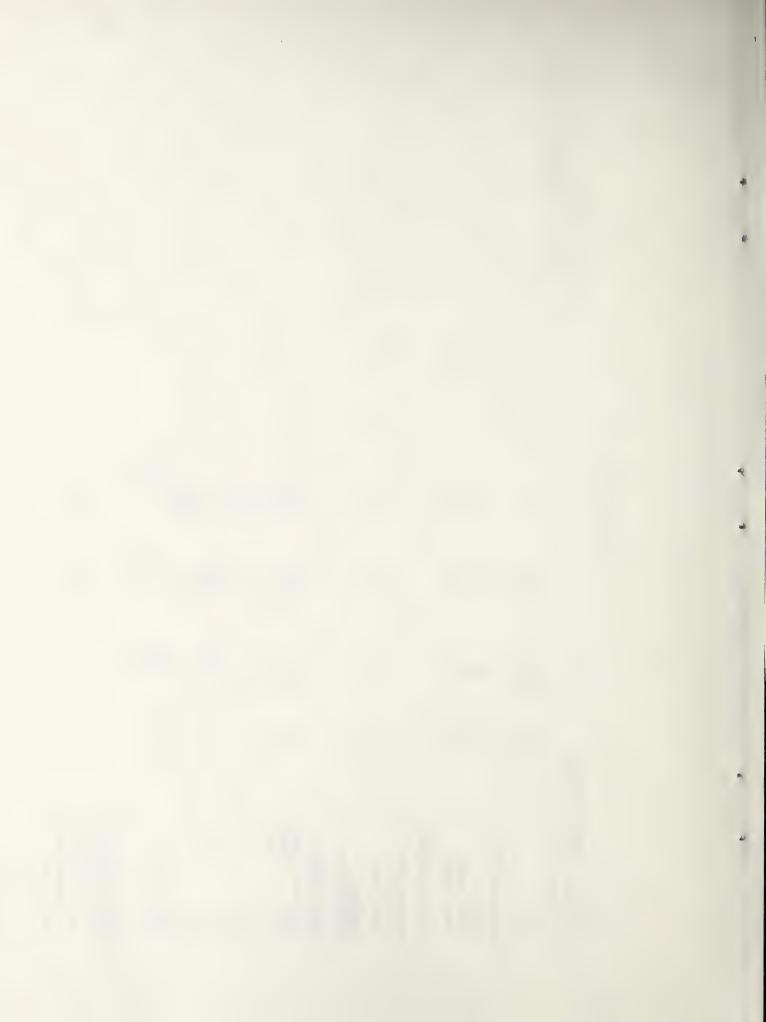
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Stream Reach Score: 65 Survey Date: 8/15/76

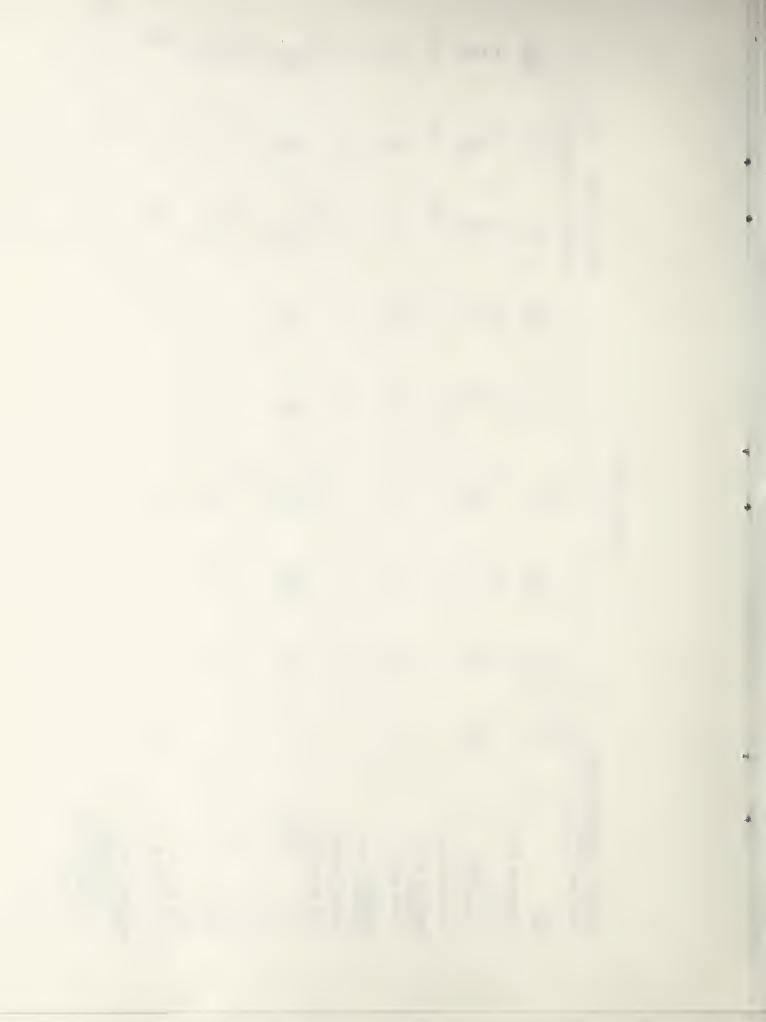
Lower Blacktail	8 T 11S R 5W	1978
Station:	Location: S 2	Water Year:

	9/15	57 46 37 37	39	21	8.25 150 359 233	41 14 4.1 1.3 138 28 2.01 <.01	
	8/17 1330	44 43 60 39	30	34	8.09 142 355 231	45 13 3.8 0.89 173 26 .01	
	7/18	62 49 57 41	96	23	8.28 160 342 222	46 11 3.2 0.79 196 23 .02 .03	
MC W	7/6	60 47 55 41	87 154	22	320		
Water Year: 1978	Date	Temperature (F°) air water water (max)	Precipitation (in) <u>Discharge</u> (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	Ca Mg Na K HCO SO <sub>4</sub> NH,  NO <sub>4</sub> 6 NO <sub>3</sub> " PO <sub>4</sub> PO <sub>5</sub> Cortho)-P	



RECORD	
DATA	
BASIC	

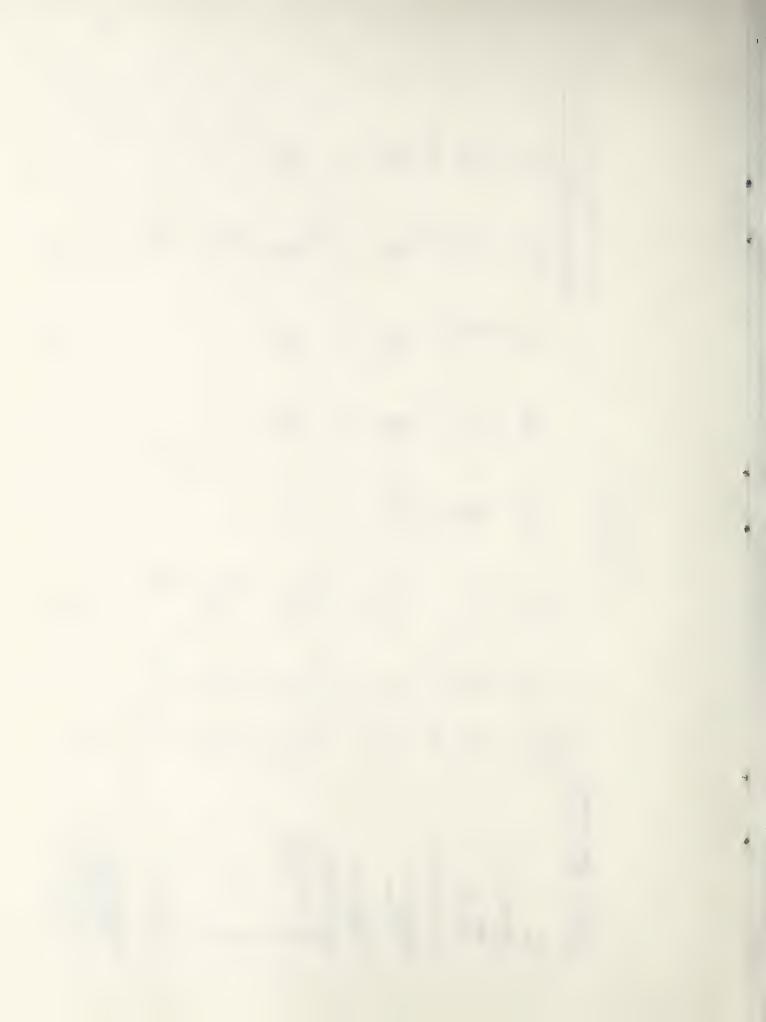
Upper Black						St	Stream Reach Score:	re:	
Location: S 35 T 11S K 5W Water Year: 1977	3					ร	Survey Date:	8/15/76	
	1976			1977	i i			6113	36/3
Date Time	9/22	10/25 1045	11/20 0945	5/2	5/12	1130	1030	1030	0060
Temperature (F°)		32	28	97	59	38	59	. 65	79
o III		34	36	41	42	39	41	42	97
water (Bax)	inst	94	}	Inst	20	51	67	inst	55
water (min)	inst	34		inst	32	39	34	inst	37
Precipitation (in)					inst	1.48	1.70	4.19	1.02
Discharge (cfs) instant crest stage	91	14 set	13	21 set	15 28	18	24 55	149	53 151
Suspended sediment (ppm)		< > <	38	7	36	13	16	111	24
Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)		357 232	368 239	8.01 121 248 161	325 211	326 212	8.05 159 227 213	252 164	7.88 154 305 195.
				41 8.6			49		46
Na X				3.0			3.9		3.3
HCO <sub>3</sub> "SO <sub>4</sub>				148			194		188
NH,				1			1		× .01
$\frac{NO_4^4 \text{ 6 NO}_3 - N}{PO_4^2 \text{ (Ortho)-P}}$				11			.002		
Biological Character Total Coliform									
(colonies/100 mls)							<b>~</b> 1		<b>'</b>
recal Colliorm (colonies/100 mls) Stock present							× 1		<b>-</b> u



Stream Reach Score:Survey Date:8/15/76	9/30	32 36 48 36	9 1.49	17	۲۶	7.90 151 296 193	55 14 5.1 1.0 184 23	.02 .13 .008	10 4 n
	9/22	36 39 37	2.29	16	\$	330			s
	8/32 1015	57 57 37	2.51	18 24	6	7.76 168 302 196	54 14 5.0 0.94 205	<.01 .15	0 0 E
	7/29 1200	64 50 61 41	1.71	21 27	< >	8.09 164 297 193	51 12 4.2 0.84 200 20	.06	<b>~</b> 5
R SW	7/13	56 48 56 38	1.07	27 54	12	285			E
Station: Upper Blacktail Location: S 35 TilS R Water Year: 1977	Date Time	Temperature (F°) air water water (max) water (min)	Precipitation (in)	Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	Ca Mg Na K K HCO	$^{\rm NH}_{\rm VO}^4$ 6 NO $^{\rm A}_{\rm VO}^{\rm NO}^4$ 6 Or $^{\rm A}_{\rm VO}^{\rm NO}^4$ 1. $^{\rm A}_{\rm VO}^{\rm A}$ 1. $^{\rm A}_{\rm VO}^{\rm A}$ 1. $^{\rm A}_{\rm VO}^{\rm A}$ 2. $^{\rm A}_{\rm VO}^{\rm A}$ 1. $^{\rm A}_{\rm VO}^{\rm A}$ 2. $^{\rm A}_{\rm VO}^{\rm A}$ 3. $^{\rm A}_{\rm VO}^{\rm A}$ 4. $^{\rm A}_{\rm VO}^{\rm A}$ 5. $^{\rm A}_{\rm VO}^{\rm A}$ 5. $^{\rm A}_{\rm VO}^{\rm A}$ 6. $^{\rm A}_{\rm VO}^{\rm A}$ 7. $^{\rm A}_{\rm VO}^{\rm A}$ 8. $^{\rm A}_{\rm VO}^{\rm A}$ 9. $^{\rm A}_{\rm VO$	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present



	ore: 77 8/15/76	6/28	66 44 50 37	> 0.42	88	54	301 196				E
	Stream Reach Score: Survey Date: 8/15/	6/20 1645	96 46 36	0.33	128 158	53	8.01 145 259 168	40 8.9 3.3 0.81 174	.03	170	, n
	Str	6/16 1115	36 44 34	1.17	158 275	28	245 159				c
		6/9	55 41 34	0.00	266 266	585	190			-	E
BASIC DATA RECORD		6/4	59 45 inst	inst	66	34	275 179				g
BASI		1978 5/24 1530	39		73 8et	48	8.00 149 270 176	39 9.3 3.4 0.82 180	.20 .05 .021	744	<1 n
	1	11/12	32 46 34	0.64	13	17	7.91 148 297 193	53 13 2.7 0.70 181 19	<.01 .15 .002	~ <b>~</b>	n 1
	rail R SW	1977 10/18 1130	57 40 46 35	0.67	16 27	. 80	7.92 178 332 216	55 15 4.9 0.93 24	.11	15	4 ° c
	Upper Black	Date Time	Temperature (F°) air water (max) water (min)	Precipitation (in)	Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	Ca M8 Na Na MCO HCO	NH, NO, 6 NO -N " PO, (Ortho)-P "	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform	(colonies/100 mls) Stock present



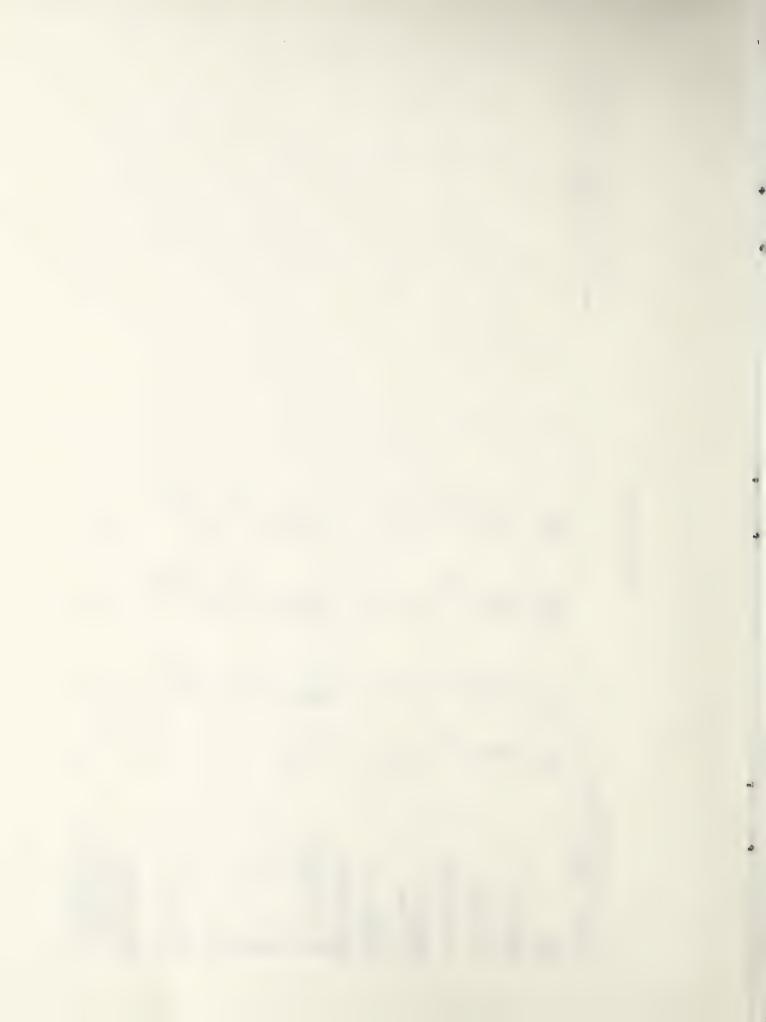
BASIC DATA RECORD

Stream Reach Score: 77

8/15/76

Survey Date:

									-
	9/15 1100	51 39 52 34	3.88	16 20	23	8.07 141 352 229	43 12 4.6 1.1 171 25	.01 .02 .011	417 1 y
	8/17 1100	37 39 55	1.28	20	24	7.96 145 348 226	46 12 3.7 0.72 177 26	.01 .04 .016	23 < 1 y
	7/18 1115	59 44 39 39	0.77	39	20	8.23 158 320 208	44 11 3.3 0.77 193 22	.05 .05 .017	197 3
R 5W	7/6	54 44 51 37	0.53	67	17	316 205			a
Station: <u>Upper Blacktail</u> Location: S 35 T 11S R Water Year: 1978	Date Time	Temperature (F°) air water water (max) water (min)	Precipitation (in)	Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	Ca Mg Na K K HCO	NH, NO, 6 NO -N " PO, (Ortho) -P "	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present



re: 67 8/15/76	6/25 1015	99 90 90 90 90 90		4°.8	47	8.01 178 400 260	65 11 1,9 0.60 217 29	.01	7 7 <sup>a</sup>
Stream Reach Score:	6/13 1145	56 41 44 34		5.2	85	318			
o, o,	5/31 1115	39 32 32		1.4	31	8.17 167 368 239	60 8.5 2.0 0.75 204	.31 T	¢ 5
	5/19 1315	36 32 32		1.3	50	356			•
	5/12 1145	55 37 32		2.0	29	355 231			
	1977 5/2 1100	51 36 inst inst		1.5 set	10	8.03 142 314 204	57 9.0 1.6 0.83 174	111	
	11/20	24 32 1ce		ice	(110)	442 287			
SW	1976 10/25 1115	32 34 1ce		1ce	31	432 281			
Station: Indian Location: S 34 T 11S R Water Year: 1977		Temperature (F°) air water water (max) water (min)	Precipitation (in)	Discharge (crs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	Ca Mg Na K K HCO SO <sub>4</sub>	NH, NO <sub>4</sub> & NO <sub>3</sub> -N " PO <sub>4</sub> (Ortho)-P "	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present

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Stream Reach Score: Survey Date: 8/15/76								
		,						
	9/30 1130	32 45 32	. 18	32	8.05 156 385 250	76 15 2.6 0.74 191 60	.05	< 2 < 2 u
	9/22 1130	36 36 36	.20	<b>×</b>	405			a
	8/32 1130	46 38 37 37	.22	6	8.11 168 386 251	73 14 2.3 0.69 204 62	4.01 T	22 23 y
	7/29 1230	65 46 37	. 38	\$	8.13 171 378 246	63 12 2.1 0.67 210 53		~ ~ ×
- NS	7/13	56 45 51 32	.86	18	375			ч
Station: Indian Location: S 34 T 11S R 5W Water Year: 1977	Date Time	Temperature (F°) air water water (max) water (min)	Precipitation (in)  Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	Ca Mg Na Na HCO SO <sub>4</sub>	NH, " NO <sub>2</sub> & NO <sub>3</sub> -N " PO <sub>4</sub> (Ortho)-P "	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present



re: 67	8/15/76	6/28	69 463 37	2.3	35	405		<b>u</b>
Stream Reach Score:	Survey Date:	6/20	61 44 36 36 36	5.0	38	8.10 170 335 218	53 10 2.4 0.65 205 14 .01	32 < 1 n
St	S	6/16		5.9	31	321 209		g
		6/9	8 4 4 5 0 9 8 6 5 6 9 6 9 6 9 6 9 6 9 6 9 6 9 6 9 6 9	6.6	780	282 183		<b>e</b>
		6/4	56 44 inst inst	.91	32	355 231		c
		1978 5/24 1645	32	1.7 set	42	7.95 170 332 216	52 9.4 2.0 0.75 204 15 .02 .09	133 < 1
		11/12	37 70 37 37 37	.15 .15	22	8.18 154 385 250	67 13 2.3 0.63 188 51 .02	32
	R SW	1977 10/18 1230	52 35 39	.15	60	7.99 170 422 274	77 15 15 207 207 65 .13	n 2 2 12
Station: Indian	S 34 T 118	1	Temperature (F°) air water water (max) water (min)	Precipitation (in) <u>Discharge</u> (cfs)  instant  crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	Ca Na K HCO SO <sub>4</sub> NH <sub>4</sub> NO <sub>4</sub> E NO <sub>3</sub> -N  PO <sub>4</sub> (Ortho)-P	Biological Character Total Coliform (colonies/100 mls) Pecal Coliform (colonies/100 mls) Stock present

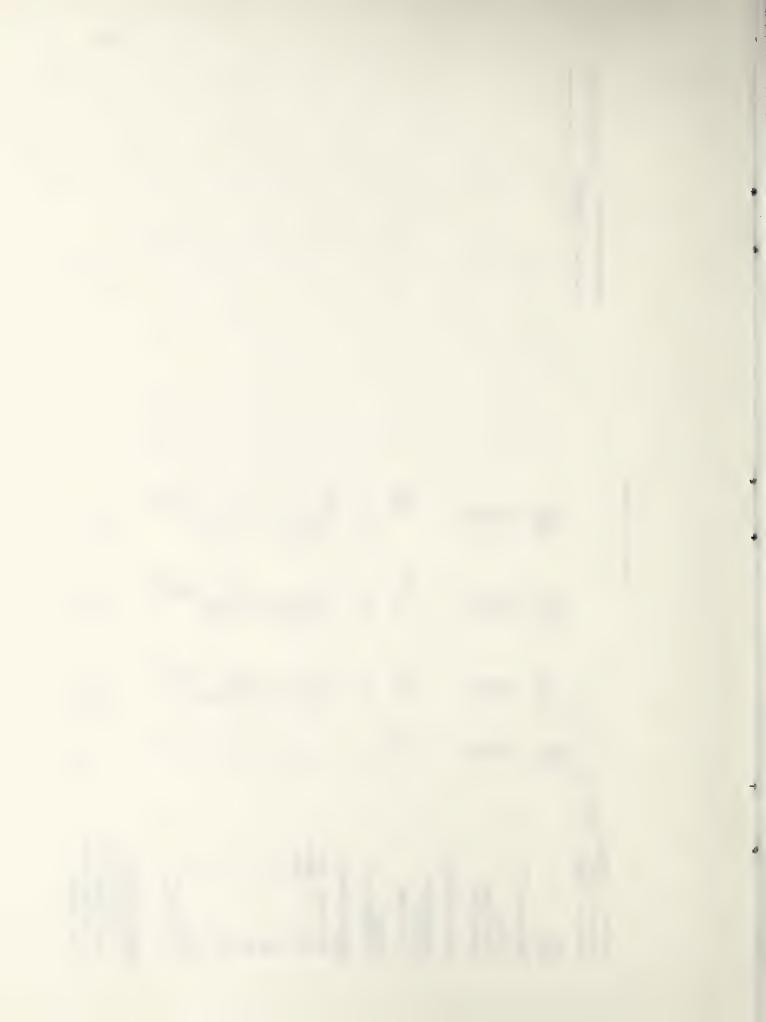
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BASIC DATA RECORD



Stream Reach Score: 67 Survey Date: 8/15/76

									an.
	9/15	39 56 56	34	.45	20	8.30 155 462 300	67 13 2.6 1.0 187 69	<ul><li>&lt; .01</li><li>.03</li><li>.004</li></ul>	70 7 y
	8/17 1245	38 40 51	38	.70	33	8.12 154 451 293	63 12 1.3 0.48 185 60	.01	80 y 2
	7/18 1200	62 45 51	07	1.6	18	8.30 176 458 298	65 12 2.1 0.59 215 62	<ul><li>&lt; .01</li><li>.05</li><li>.010</li></ul>	193
R 5W	7/6	51 42 47	39	2.2	21	426			<b>c</b>
Station: Indian Location: S 34 T 11S R Water Year: 1978	Date Time	Temperature (F°) air water water (max)		Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	Ca Ma Na Na NA NCO SO <sub>4</sub>	NH, NO, 6 NO, -N " PO, (Ortho) -P "	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present



		5/21 1800	52 23 34		2.0	28	403		
e: 66	8/13/76	5/12 1645	2 2 2 2		.80	63	424 276		
Stream Reach Score:	Survey Date:	5/2 1900	52 4.8 5.4 3.5		1.2 3.5	16	340 221		
S	S	4/21	46 48 32		.52	æ	8.24 177 342 222	40 4.6 18 3.7 216 10	7.01
		4/14	38 32 inst inst		1.2 set	58	336		
		1977 2/21 1450	28		ice	ice	452 294		
		11/30	30 36 1ce	•	2.5	52	458 298		
1		10/25	36		2.3	22	500 325		
anyon	R 10W	1976 9/21	inst		2.3				
Lower Clark	Location: S 35 T 95 R Water Year: 1977	Date Time	Temperature (F°) air water water (max) water (min)	Precipitation (in)	Discharge (cfs) Instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	Ca Mg Na K K HCO SO <sub>4</sub>	NH, NO <sub>2</sub> 6 NO <sub>3</sub> -N " PO <sub>2</sub> (Ortho) -P "

Biological Character
Total Coliform
(colonies/100 mls)
Fecal Coliform
(colonies/100 mls)
Stock present

BASIC DATA RECORD



ore: 99	8/13/76	9/29	40 50 57 44	 1. E.	16	7.91 250 388 252	62 7.4 31 4.9 306	.10	88 143 y
Stream Reach Score:	Survey Date:	9/23	50 52 64 42	.26	21	495			э
S	รั	8/31 2030	47 52 66 48	.26	(109)	8.10 242 455 296	70 7.8 29 . 5.4 . 295	<ul><li>.01</li><li>.10</li><li>.016</li></ul>	, 2 ¢
		7/28 1230	75 63 68 68	777	(110)	7.71 275 503 327	80 7.6 23 5.6 336.	<pre>&lt;.01 .043</pre>	17 14 y
		7/15	73 56 70 45	1.1	.32	500 325			э
		6/23 1700	77 59 78 54	.54	19	7.70 254 510 332	75 7.4 26 5.4 310 9.0	6.01 7.01	r <sup>8</sup> 7
		6/12 1630	52 61 79 37	.50	6	460 299			
Canyon	R 10W	5/28	41 46 52 37	2.3	30	8.12 186 367 239	51 6.0 22 3.1 227 8.6	 	7 2 7
Lower Clar	Location: S 35 T 9S F Water Year: 1977	Date Time	Temperature (F°) air water water (max) water (min)	Precipitation (in)  Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	Ca Mg Na K HCO	$^{NH}_{NO}^{4}$ 6 NO $^{-N}_{4}$ " $^{PO}_{4}^{2}$ (Ortho) -P "	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present

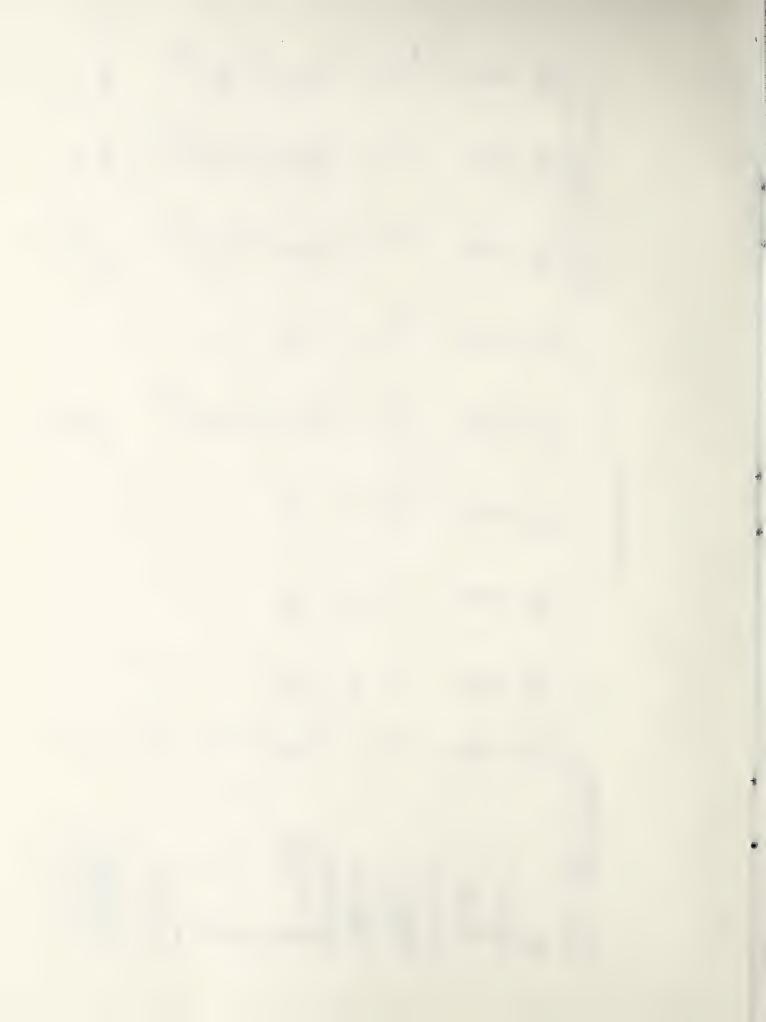


28 2.2 251 7 <.01 .001	6	2442 287 713 7.3 28 3.1 296 8 8 .14 .009
		71 66 51 58 v v n



		9/13 1915	4 6 4 9 3 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	.98	92	8.27 234 515 335.	60 6.7 26 4.2 286 11	.007	5020 87 u
6	78		41 48 67 45	1.2	09	8.23 221 500 325	61 6.5 23 2.8 269 10	.009	
core: 99	8/13/78	8/16	. 4404		9				1000 83
Stream Reach Score:	Survey Date:	7/18	72 57 63 45	7. 7 1.2 5.9	36	8.19 245 495 322	58 7.3 26 4.0 298 10	.028	1810Q 100
07	v.	6/27	63 54 61 41	3.3	24	512 333			>
		6/19 2015	52 50 59 41	2.3	25	8.03 216 433 281	88 7.4 26 1.4 259 8	<.01	6370 409 y
		6/13 2100	64 60 60 60	4.4 2.5	28	369			*
		6/8 1830	74 57 62 43	4.1	34	361 235			٨
1	-	6/2 1800	52 53 56 38	2.4	28	352 229			*
nyon	R 10W	5/26 1500	52 45 set 5/7	9.6 A	119	7.85 148 284 185	37 4.1 17 2.8 178 4	.08	1320 < 1
Lower Clark C	Location: S 35 T 95 R Water Year: 1978	Date Time	Temperature (F°) air water water (max) water (min)	Precipitation (in) <u>Discharge</u> (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	Ca Mg Na K HCO SO <sub>4</sub>	NO2 6 NO -N " PO2 (Ortho)-P "	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present

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		5/28 1800	784 P	& @ & N	179	8.12 129 270 176	37 4.1 17 2.4 158	.03	7 7 7
core: 109	8/13/76	5/21	56 47 50 31	3.2	122	273			
Stream Reach Score:	Survey Date:	5/12 1545	70 50 50 32	1.7	178	300			
		5/2 1800	0446 0444	3.5	27	242			
		4/21	49 35 41 32	2.8	17	7.95 111 205 133	24 3.3 10 3.5 136	90	
		1977 4/14 1145	32 34 39	1.9	114	272			
		11/30	30	.93	34	375			
		10/25	36 47 32	1.3 Bet	7	368			
Upper Clark Canyon	S R 9W	1976 9/21	inst	1.6					
Station: Upper Cla	s: S	ı	Temperature (F°) air water water (max) water (min)	Precipitation (in)  Discharge (cfs)  instant  crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	Ca MB Na Na K HCO SO <sub>4</sub>	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls)



	Stream Rea	
BASIC DAIA KECUKU		
	Clark Canyon	MG W COT +

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ore: 109	8/13/76						,			
Stream Reach Score: 109	Survey Date:	9/29 1645	41 45 47 37		8. 28.	42	8.20 201 368 239	74 6.5 18 245 9	.15	13 14 y
St	Su	9/23	38 34 34		69.	18	400			>
		8/31 1915	48 46 55 42		.85	20	8.11 209 371 241	69 6.2 16 2.0 255	< .01 .28 .047	17 8 u
		7/28	72 51 57 45		1.6	09	7.90 212 355 355 231	61 5.8 15 1.9 258 6	.15	8 8 8 × × ×
		7/15 0915	59 46 54 41		1.4	26	368			<b>~</b>
		6/23 1600	72 54 63 43		2.4	22	8.11 202 395 257	65 5.8 15 2.0 247 4	.01 .06 .040	r & 2
nyon		6/12	62 55 57 36		3.9	28	372 424			
Station: Upper Clark Canyon Incarion: S. 6. T. 10c. R. 6	777	Date Time	Temperature (F°) air water water (max) water (min)	Precipitation (in)	Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	Ca Mg Na K HCO SO <sub>4</sub>	NH, NO, & NO, -N " PO, (Ortho)-P "	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present





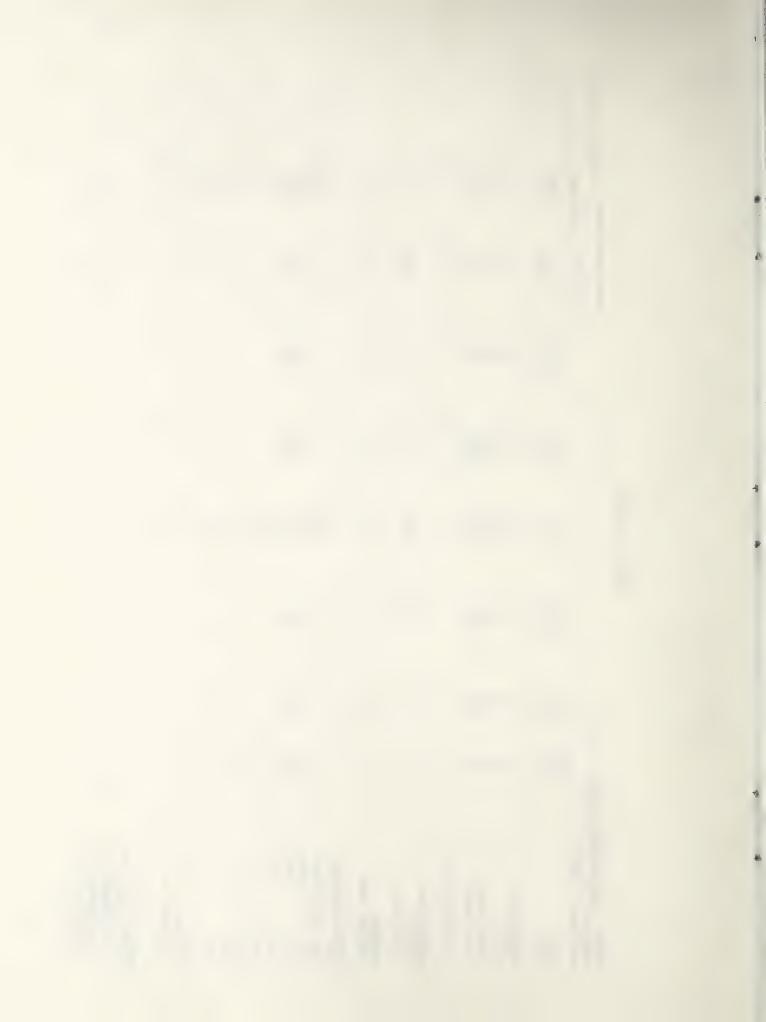
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6/13 1930 63 51 64 40 40 304 198		6/27 1815 63 63 63 64 11.2 11.2 11.2 11.2 11.2 11.2			6/13 1930	63 51 64 40		24	304	56 6.2 15 1.9 235 3 3 <b>&lt;&lt;</b> .01 .03	a
.8 173 18 18 18 18	6/13 1930 63 51 64 40 40 304 198	6/13 6/19 6/27 1930 2100 1815 51 42 63 51 46 52 64 57 64	6/13 6/19 6/27 1930 2100 1815 51 42 63 51 46 52 64 57 64 65 57 64 65 57 64 66 57 64 67 6	Upper Clark Canyon 6 T 10S R 9W 1978						3.5 1.3 1.8 1.8 1.8 1.8 1.8 1.8 1.8 1.8	
260 11.8 11.8 11.8	6/13 1930 63 64 64 64 64 64 64 64 64 64 64 64 64 64	6/13 6/19 6/27 1930 2100 1815 51 42 63 51 46 52 64 57 64	6/13 6/19 6/27 1930 2100 1815 51 42 63 51 46 52 64 57 64	Clark Canyon 10S R 9W				35	7.76 128 226 147	32 3.5 13 153 3 02 .02 .046	s) 515 .
Stream Re Survey Da  6/27 1815 164, 1815 164, 414 414 414 414 414 414 411 11 11 11 11	rvey Date: 8/13/76  7/18 8/16 1645 1900  7/18 8/16 1900 1645 1900 1900 1900 1900 1900 1900 1900 1900	8/13/76 1900 43 44 44 42 42 42 2.8 8.17 186 422 274 557 57 57 57 57 57 57 57 57 57 57 57 57			9/13 1730	6810	2.23	10	8.19 183 427 278	57 5.6 15 22.5 22.6 6 6 .039	270 9



core: 97 8/13/76	5/28 1845	3 4 6 5 3 9 9 6 5	0.88	164	8.01 147 312 203	32 4.9 28 5.6 180	.059	10
Stream Reach Score: Survey Date: 8/13	5/21 1745	55 50 32 32	1.66	1140	304 198			
ห ห	5/12 1610	68 64 32	0.45	87	297 193			
	5/2 1815	48 44 inst inst	0.23	465	235			-
	4/21 1115	50 39 . 1ce	inst < 1.5	153	8.00 118 238 155	20 3.5 22 4.6 144.	. 03	
	1977 4/14 1215	38 32 1ce 1ce	< 1.5	543	227			
	11/30	30 32 1ce	ice	1ce	479 311			
Mon Mon	1976 10/25 1615	34 36 32 32	.65	31	441 278			
Station: R. Fork Clark Canyon Location: S 6 T 105 R 9W Water Year: 1977		Temperature (F°) air water water (max) water (min)	Precipitation (in)  Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	Ca Mg Na K K HCO	NH, NO, NO, NO, NO, NO, NO, NO, NO, NO, NO	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present

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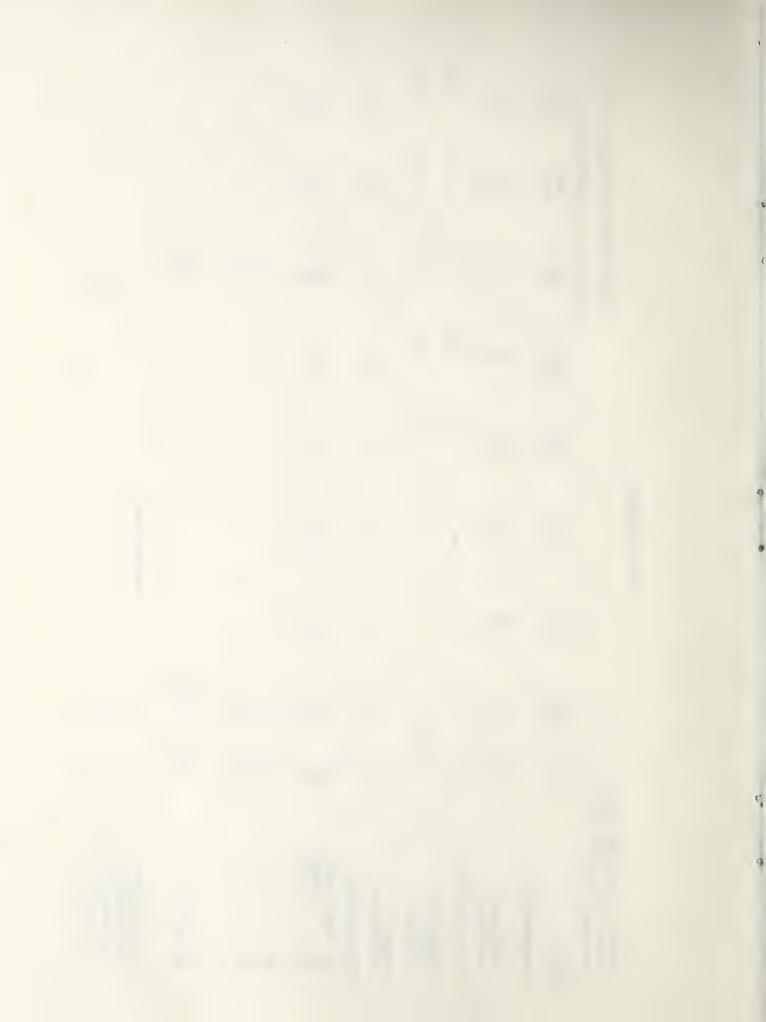
ore: 97 8/13/76								
Stream Reach Score: Survey Date:	9/29	37 38 50 32	0.57	9390	8.11 100 204 133	20 2.7 28 5.0 122		TNTC TNTC
St.	9/23	48 39 32	> 1.29	231	412 268			>
	8/31 1945	20 30 30 30 30 30 30 30 30 30 30 30 30 30	1.17	34	8.32 207 412 268	44 6.3 48 7.1 252 19	<b>6.</b> 01 .04 .059	220 140 u
	7/28 1130	642	1.19	18	8.37 215 402 261	47 6.4 42 7.2 257	90.	1000 940 u
	7/15	99 39 39 39	0.74	32	540 351			<b>.</b>
	6/23 1630	81 72 73 52	0.96	23	8.21 281 600 390	64 8.3 56 7.6 23	<ul><li>&lt; .01</li><li>.04</li><li>.010</li></ul>	8 2
M6	6/12	57 63 72 32	1.39	269	358 233			
Station: E. Fork Clark Canyon Location: S 6 T 105 R 9W	1	Temperature (F°) air water (max) water (min)	Precipitation (in)  Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	Ca Mg Na Na HCO So <sub>4</sub>	NH4 NO4 6 NO -N " PO2 (Ortho) -P "	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present



ork Clark Car	you					S	Stream Reach Score:	re: 97	
1978 R	MC .		0			S	Survey Date:	8/13/76	
Date	1977 10/17 1130	11/10	19/8 3/29 1300	4/5	4/11	4/19	4/25	5/3	5/9 1815
Temperature (F°) air water water (max) water (min)	54 37 32	34 52 32 32	61 34 1ce 1ce	39 34 1ce	44 36 inst inst	43 45 32	57 41 50 32	24.5 33.4 3.4 3.4 3.4 4.6	55 43 37
Precipitation (in)	0.24	0.32		Inst	0.28	0.57	0.07	0.62	1.16
Discharge (cfs) instant crest stage	<.10*	ice	.53	.18	.16	.18	.34	.34	2.6
Suspended sediment (ppm)	29	15	714	63	140	242	315	123	11500
Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	8.01 205 420 273	7.79 175 380 247	215 140	305 198	262 170	289 1 <b>88</b>	7.71 156 280 182	255	228 148
Ca Na Na HCO So <sub>4</sub>	53 7.5 58 8.0 250 17	53 8.3 44 6.4 213 15					24 4.1 34 4.3 187 8		
NH <sub>4</sub> & NO <sub>3</sub> -N " NO <sub>2</sub> & NO <sub>3</sub> -N " PO <sub>4</sub> (Ortho)-P "	.01	<ul><li>.01</li><li>.06</li><li>.030</li></ul>					.01		
Biological Character Total Coliform (colonies/100 mls)	16	80	# 875	*Stationed moved			2750		
recal Collform (colonies/100 mls) Stock present	×	65 y	a	g	g	ď	! c	a	c

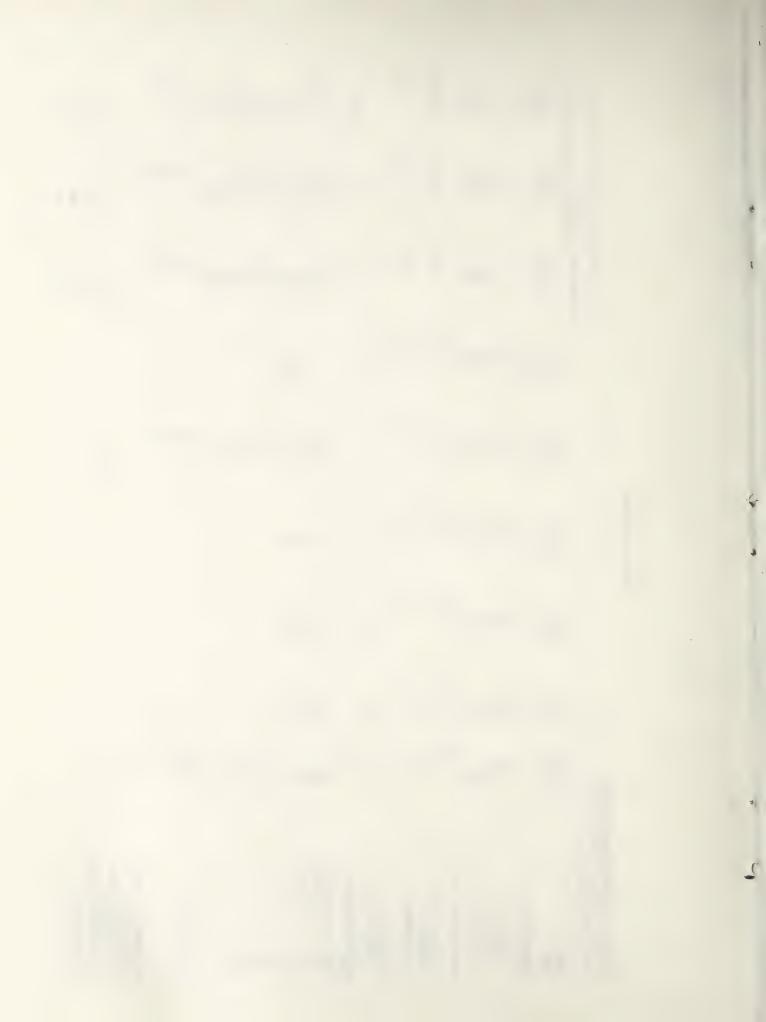
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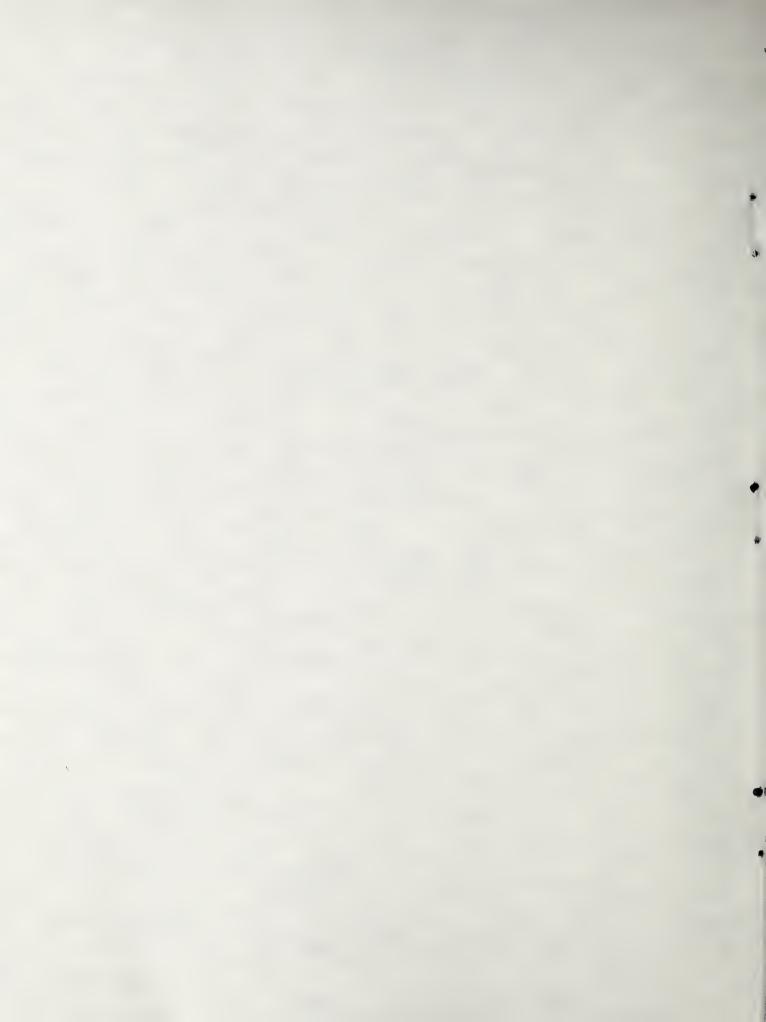
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Station: E. Fork Clark Canyon Location: S 6 T 105 R 9W Water Year: 1978	on W					St	Stream Reach Score: Survey Date: 8/13	Score: 97 8/13/76	
Date Time	5/26 1400	6/2 1700	6/8 1745	6/13 2015	6/19 2130	6/27 1830	7/18 1730	8/16 2000	9/13 1830
Temperature (F°) air water water (max) water (min)	48 43 set	6 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	77 63 65 41	9 9 3 9 9 9	43 47 63 39	62 68 32	71 66 dry dry	41 47 dry dry	47 46 dry dry
Precipitation (in)	4.05	0.40	0.00	0.46	0.14	0.89	1.66	1.29	> 2.02
Discharge (cfs) instant crest stage	2.2	1.6	.30	.30	.15	.10	.17	.16	.43
Suspended sediment (ppm)	56	30	20	23	15	29	87	113	1496
Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	7.70 85 178 116	199 129	215 140	231 150	8.05 128 158 168	313 203	8.15 217 340 221	8.25 147 375 244	8.15 146 343 223
Ca Mg Na Na HCO	19 3.2 15 2.9 102				31 5.5 24 4.5 154		30 5.3 30 8.5 265 16	32 4.3 31 4.8 179 32	29 11 38 4.3 173 15
NH4 & NO -N " NO2 & NO -N " PO2 (Ortho)-P "	.02				.09 2.01 .074		.01	.13	. 01 . 03 . 085
Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present	1100 3	a	*	5	2400 28 u	э	22700 267	2670 303	2870 33

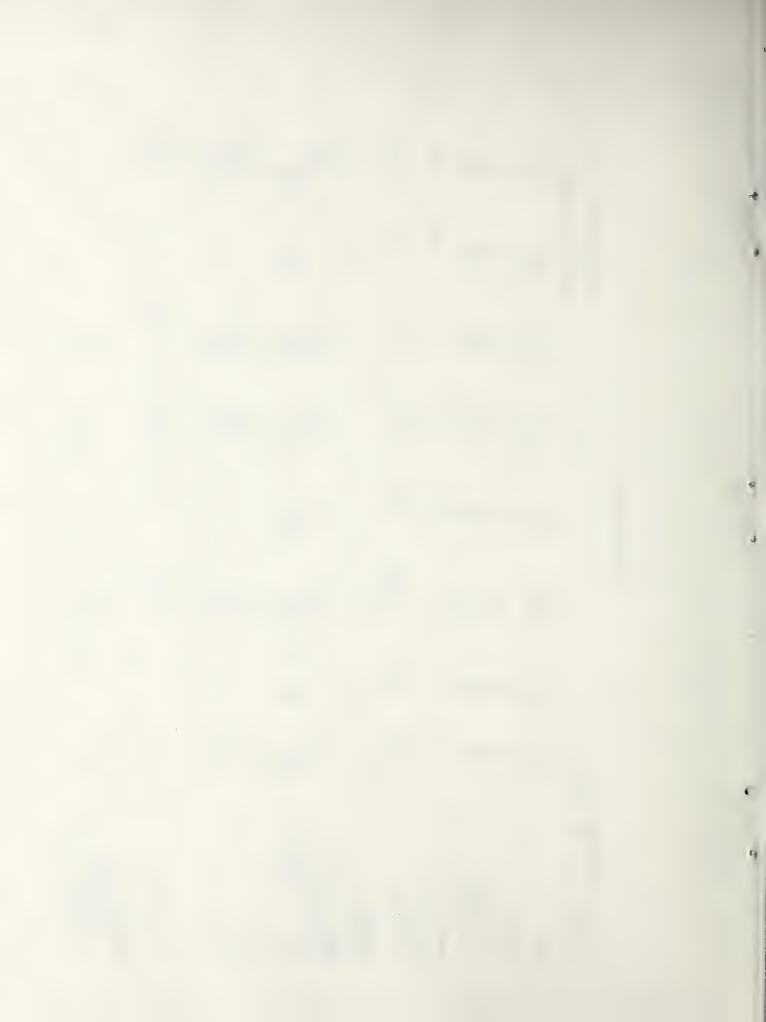


Biological Character
Total Coliform
(colonies/100 mls)
Fecal Coliform
(colonies/100 mls)
Stock present

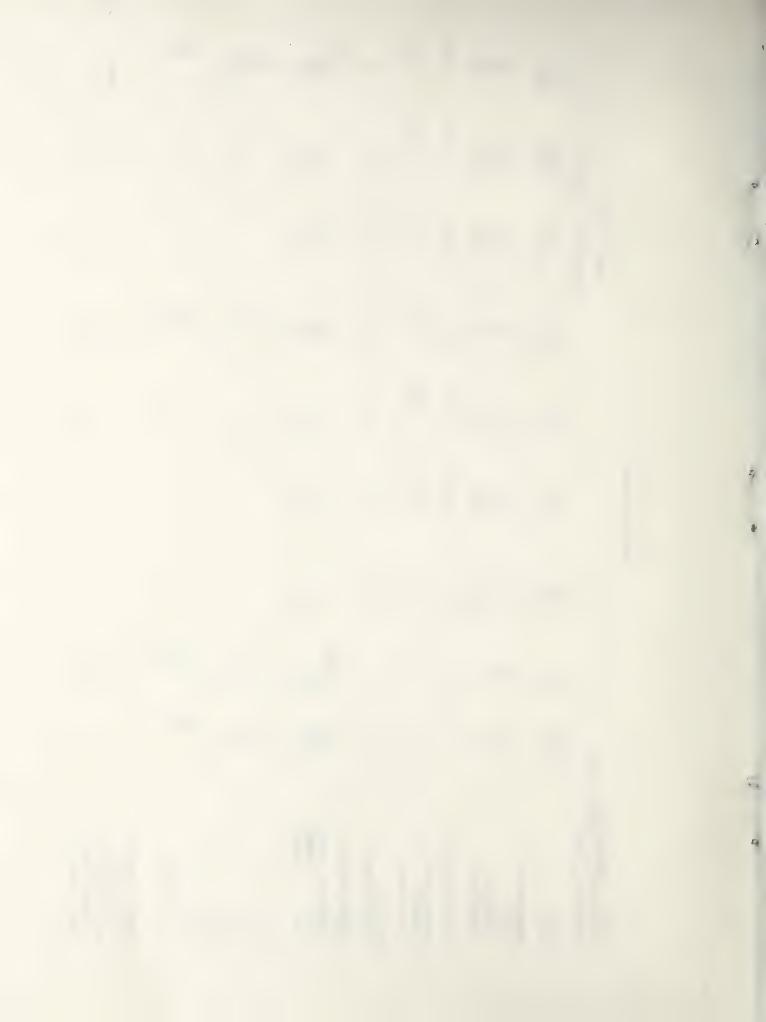
			5/21 1030	54 41 56 35	1.35	1.4	28	425 276	
	. 67	8/15/76	5/11 1015	38 5 34 5 34 5	1.38	.85	81	418	
	Stream Reach Score: 67	Survey Date: 8/1	5/1 1030	61 41 52 36	0.09	.69	\$ >	405	
	Ś	Š	4/21	57 42 50 32	inst	3.5	۲Ü	7.89 183 358 233	44, 7.8 9.8 233 6
			4/14	32 37 inst inst		1.3	14	365	
BASIC DATA RECORD			1977 2/26 1200	32		11.	14	392 255	
BAS			11/30	32		1.1	35	383 249	
			10/27	32		1.2	11	375	
,		K 78	1976 9/21			1.5			
	Little Sage	Location: S 7 T 12S Water Year: 1977	Date Time	Temperature (F°) air water water (max) water (min)	Precipitation (in)	Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	$\begin{array}{cccccccccccccccccccccccccccccccccccc$



Score: 678/15/76	9/27	63 50 36	1.00	1.1	10	8.30 171 327 213	58 9.1 12 6.8 208	.09	φ <sup>Φ</sup> 3
Stream Reach Score:Survey Date:8/15/7	9/17	75 76 36 36 76	0.82	1.2	20	359			э
St.	8/29 1030	48 66 41	0.95	1.2	20	8.19 182 333 216	57 9.1 12 6.2 222 6	.003	07 07 17
	7/26 1015	51 52 69 46	1.54	1.2	66	7.95 198 353 229	60 9.2 11 6.6 241 5	.01	320 588 y
	7/12	28 7	> 0.15	1.1	55	322 216			>
	6/23 0930	6.4 5.4 5.4 5.4	n.8.	.99	17	7.98 199 415 270	58 9.2 12.5 5.9 5.9	<ul><li>&lt; .01</li><li>&lt; .01</li><li>.014</li></ul>	370 390 y
	6/13 1630	57 59 66 36	1.70	1.2	15	394 256			
R 7W	5/28 1030	43 39 54 36	0.78	1.4	30	7.82 210 428 278	61 9.4 13 6.9 256	T	8 12
Station: Little Sage Location: S 7 T 12S R Water Year: 1977	Date Time	Temperature (F°) air water water (max) water (min)	Precipitation (in)	Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (umhos) TDS (mg/l)	Ca Mg Na K K HCO SO <sub>4</sub>	NH, NO <sup>2</sup> 6 NO <sub>3</sub> -N " PO <sup>2</sup> (Ortho)-P "	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present



11ttle Sage 7 T 12S R 7M 1978	1977		1978				ch Sc	8/15/76	
10/15 11 1645 11	= -	11/13	4/4	4/12	4/19	4/26	5/4 1245	5/10 1245	5/26 2000
64 46 30 34		48 48 32	39 38 inst inst	\$ \$ \$ \$ \$	28 34 34 34	25 6 4 3 5 2 6 3 5 2 6	3.5.4.3. 3.6.4.3.	51 46 35 36	49 52 33
.61		0.41	inst	99.0	0.27	п.в.	1.15	0.20	0.76
1.2		1.2	1.1 set	1.3	.85	1.2	1.4	.85	1.1
22		۱ń	24	23	15	21	35	29	25
7.85 168 335 218		8.05 163 325 211	342	342 222	363	7.70 197 370 240	371 241	368 239	8.28 169 328 213
58 9.7 14 7.3 205 5.		70 11 14 7.2 7.2 5				60 9.7 13 8.3 236 3			40 7.3 10 5.6 203
.03		60°. 900°.				.01 .06 .022			.01
43 18 y		17 8 y	e	c	d	2100	a	ß	3800 2 n



	8/15/76	9/11 1730	43 57 43	1.63	1.6	30	8.38 148 368 239	47 8.0 11 7.7 170 6	<ul> <li>.01</li> <li>.032</li> </ul>	38000 2000 y
	Stream Reach Score: Survey Date: 8/	8/14 9/ 1745 17	55 53 47	0.41	.92	50	8.60 . 1 173 . 1 348 . 3 226 . 2		.027	24300 380 85 20
	Str	7/19 1915	09 09 66 47	0.17	.50	51	8.25 154 319 207	38 7.8 12 8.5 188 2	<ul><li>∠.01</li><li>.034</li></ul>	70300 29 u
		6/27 1600	73 64 43	0.32	.60	63	342			<b>3</b>
BASIC DATA RECORD		6/19 1745	61 60 63 44	0.18	.92	52	8.50 152 292 190	40 7.8 13 5.4 183 5	<.01 .024	17800 17
BAS		6/14 2000	57 56 66 66	07.0	.69	32	305 198			3
		6/8 1200	66 53 64 42	0.00	1.2	29	345		-	>
,	R 7W	5/31 1800	46 50 60 39	0.02	1.2	30	323 210			>
	Station: Little Sage Location: S 7 T 12S Water Year: 1978	Date Time	Temperature (F°) air water water (max)	Precipitation (in)	Discharge (cfs) Instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)		$NO_4^2$ 6 $NO_3$ -N " $PO_4^2$ (Ortho)-P "	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present



Biological Character
Total Coliform
(colonies/100 mls)
Fecal Coliform
(colonies/100 mls)
Stock present

			5/21 1230	61 55 66 35		3.2	35	436 283	
	re: 49	8/17/76	5/11	. 25 46 34		3.3	59	478 311	
	Stream Reach Score:	Survey Date:	5/1 1230	55 50 36 36		.52	63	456 296	
	S	S	4/21	51 54 34		.39	24	8.19 217 448 291	48 15 9.5 6.3 265 18 
			4/14	30 41 inst		2.6 set	146	340	
BASIC DATA RECORD			1977 2/26 1230	25 32		ice	104	435 283	
BAS			11/30	32		2.3	67	425	
			10/27	4 34 34 34		2.1 set	69	358 233	
•		7W	1976 9/21	inst		3.0			
	Lower Basin	Location: S 30 T 12S R Water Year: 1977	Date Time	Temperature (F°) air vater water (max) water (min)	Precipitation (in)	Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	Ca Na K HCO SO <sub>4</sub> NH4  NO4  NO2  Cortho)-P "

- 4



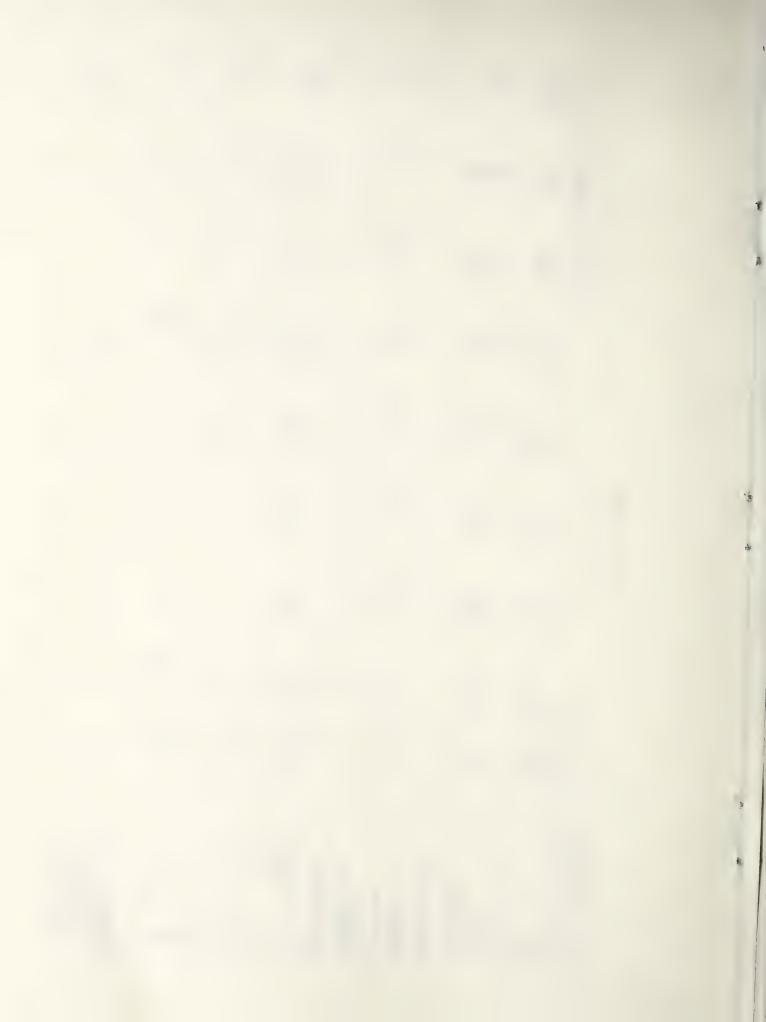
	Score: 49 8/17/76	9/27	58 52 37		.81	< 5	8.35 139 272 177	47 10 9.2 5.0 165 9 .09	510 490 y
	Stream Reach Score: Survey Date: 8/17/7	9/17	48 50 65 41		88.	2.5	278 181		>
	Su	8/29 1245	63 54 74 43		99.	2.5	8.62 166 315 205	49 14 9.1 5.2 182 8 8 .04	38 24 y
		7/26	65 58 77 48		.75	80	8.58 148 372 242	46 11 9.2 3.8 166 8 8 	7 120 u
BASIC DATA RECORD		7/12	73 61 79 45		. 18.	12	368 239		s
BASIC		6/23	79 72 75		.95	22	8.48 171 378 246	44 14 9.1 4.1 209 10 6.01 6.120)	1 v n
		6/13 1900	57 65 80 38		.95	10	368 239		
	RZ.	5/28	46 48 63 37		2.4	79	8.18 216 447 291	58 14 13 4.0 264 19 	~ ~
	Station: Lower Basin Location: S 30 T 125 R Water Year: 1977	Date	Temperature (F°) air water water (max) water (min)	Precipitation (in)	Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	Ca Na Na K HCO <sub>3</sub> SO <sub>4</sub> NH <sup>4</sup> & NO <sub>2</sub> -N " PO <sup>2</sup> (Ortho)-P "	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present

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1978	W/					Su	Survey Date:	8/16/76	
	1977 10/15 1900	11/13	1145	4/12	4/19 1145	4/26	5/4	5/10	5/26 1915
Temperature (F°) air water water (max)	51 67 53 34	788 34 34 34	39 38 inst	45 55 32	32 32 34 35 37	47 47 32	32 85 32	25 95 35 35 35	52 51 63 34
Precipitation (in)									
Discharge (cfs) instant crest stage	.90	1.7	.39	.43		2.7	89.	1.9	2.7
Suspended sediment (ppm)	9	22	20	15	21	66	33	7.1	28
Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	7.89 151 310 202	8.00 149 300 195	318 207	412 268	420	7.95 211 420 273	356	255	8.28 167 323 210
	50 11 9.5 5.3 184	59 11 8.7 5.3 6				59 14 10 5.5 253			41 8.8 6.8 2.6 201
6 NO -N " (Ortho) -P "	.06	.07				.09			A A 0.0.0
Biological Character Total Coliform (colonies/100 mls) Fecal Coliform	210	30	•		·	0096			2900
(colonies/100 mls) Stock present	230 y	80 ×	а	a	c	1 0	ø	а	<sup>4</sup> ¤



					•				
sre: 49 8/16/76	9/11	43 45 45 45	3.1	22	8.55 150 377 245	44 15 8.2 8.2 3.9 177 26	<ul><li>&lt; .01</li><li>&lt; .01</li><li>.012</li></ul>	11600	307
Stream Reach Score: Survey Date: 8/16	8/14	54 74 78	1.0	21	8.87 154 299 194	32 14 8.0 2.5 166	<ul><li>&lt; .01</li><li>&lt; .01</li><li>.007</li></ul>	2670	15 u
Str	7/19	74 68 75 79	.95	18	8.72 140 382 248	(28) 14 8.2 3.4 158 24	.01	22700	27 n
	6/27	74 67 71 43	3.8	18	351 228			-	G
	6/19	61 59 44	2 2 2 2	23	8.47 165 318 207	44 11 8.2 2.6 198 15	<ul><li>&lt; .01</li><li>&lt; .01</li><li>.026</li></ul>	17200	20 n
	6/14	66 60 72 73	1.8 5.3	20	313 203				и
	6/8 1115	66 55 39	1,3	21	326 212	•			ď
MZ	5/31	44 47 39 39	2.9	07	322				и
Station: Lower Basin Location: S 30 T 125 R Water Year: 1978	Date	Temperature (F°) air water water (max) water (min)	Precipitation (in)  Discharge (cfs)  instant  crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	Ca MB Na K HCO SO <sub>4</sub>	NH4 NO <sup>2</sup> & NO <sub>3</sub> -N '' PO <sup>2</sup> (Ortho)-P ''	Biological Character Total Coliform (colonies/100 mls)	recal Collidem (colonies/100 mls) Stock present

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BASIC DATA RECORD



(colonies/100 mls) Stock present

(colonies/100 mls)

Fecal Coliform



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Station: Upper Basin Location: S 36 T 125 R 7W Water Year:						Sura Sura	Survey Date: 8/16/76
Date Time	6/13	6/23 1030	7/12 0930	7/26 1130	8/29 1130	9/17	9/27 1700
Temperature (P°) air water water (max) water (min)	61 57 66 37	68 57 63 45	62 50 64 45	55 54 68 46	57 50 66 43	44 45 59 41	60 51 53 36
Precipitation (in)	1.97	n.s.	> 0.73	1.76	1.12	0.85	0.86
Discharge (cfs) Instant crest stage	3.6	1.0	1.3	1.2	1.2	1.2	1.0
<u>Suspended</u> sediment (ppm)	11	18	15	23	11	12	< 5
Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	312	8.00 169 345 224	297 193	7.97 172 303 197	8.21 176 303 197	313 203	8.01 166 303 197
Ca ""  Mg ""  K "  HCO ""  SO 4  NH 6 NO -N "  PO 2 (OFFRO) -P "		52 6.3 5.5 207 3 6.01 .03		60 6.6 5.4 3.4 209 4 4	62 7.8 6.5 3.6 215 4 4 .04 .09		63 7.8 7.0 3.9 202 3.3 .08
Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present		r 7 1	5	512 83 u	195 245 u		29 22 u

BASIC DATA RECORD

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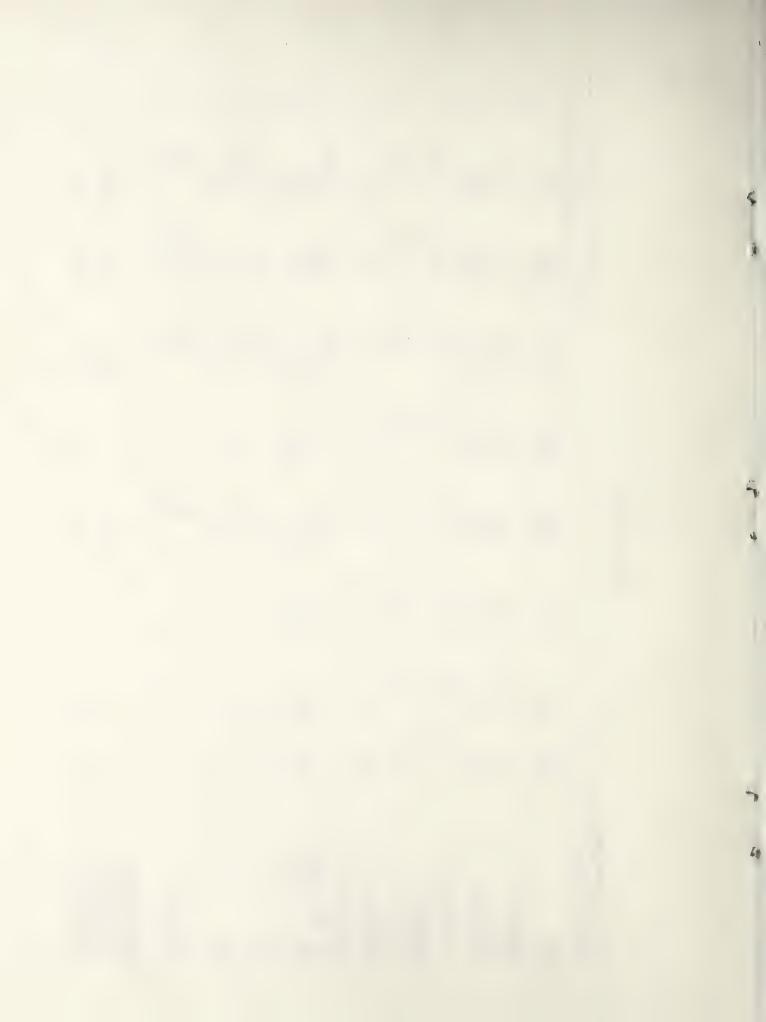
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Station: Upper Basin						Stı	Stream Reach Score:	re: 74	
S	A					Sun	Survey Date:	8/16/76	
1	1977 10/15 1800	11/13	1978 4/4 0945	4/12	4/19	4/26	5/4	5/10 1115	5/26
Temperature (F°) air water water (max) water (min)	52 52 52 53 54	42 47 33	37 36 inst	37 47 32	32 32 32	40 46 36	31 36 35	3 6 32	8 9 7 9 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
Precipitation (in)	0.80	0.35	inst	1.07	0.53	0.56	0.35	0.20	1.48
Discharge (cfs) instant crest stage	1.3	1.2	1.4 set	1.3	 	2.8	1.8 8.4	2.6	2.6
Suspended sediment (ppm)	\$ >	18	20	15	15	27	21	21	16
Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	7.69 148 295 192	7.90 141 267 174	242	263 171	260	7.75 141 258 168	247	265	8.01 141 268 174
Ca Mg Na K K HCO	54 6.8 6.0 3.1 181	55 6.4 6.4 3.4 3				46 5.6 4.0 2.6 170			35 4.5 3.6 2.0 170
NH4 & NO -N " NO & (Ortho) -P "	. 09	.08				. 01 . 02 . 057			.01
Biological Character Total Coliform (colonies/100 mls) Fecal Coliform	93	37			-	2120			1020
(colonies/100 mls) Stock present	68 y	25 u	а	c	c	<b>1</b> a	а	а	u u



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Upper Basin 36 T 125 R 1978	7.4					ง ง	Stream Reach Score: 74 Survey Date: 8/16/76	re: 74 8/16/76
	5/31 1515	6/8 1015	6/14 1830	6/19 1615	6/27 1430	7/19 1645	8/14	9/11 1445
	39 45 55 37	59 50 39	67 55 63	59 57 43	69 62 42	62 65 65 65	50 44 84 84	43 44 61 37
	0.13	0.05	0.53	0.17	0.76	0.23	0.45	2.10
	2.2	1.7	1.3	1.4	1.0	.80	. 90	1.4
	28	21	32	34	32	23	57	63
	272 177	288 187	291 189	8.07 165 298 194	339	8.03 173 354 230	8.25 185 363 236	8.00 152 344 224
				47 7.0 5.1 198 3		50 7.6 5.9 3.1 212 5	55 6.6 5.5 3.0 3	45 6.5 6.0 185 5
				.02		.02 .05 .112	.05 .05 .139	.03 .01
	<b>E</b> .	æ	c	8270 2 n	ជ	24200 161 u	2370 1260 y	34300 1590 y



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		6/13	57 73 37		3.5	A ~	760	5
re: 67	8/16/76	5/28 1200	 4.3 5.7 3.5 7.5 8.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9		3.1	19	8.21 230 504 328	63 20 15 1.8 281 26 
Stream Reach Score:	Survey Date:	5/21 1200	54 50 61 37		1.9	22	454	
03	03	5/11 1145	46 45 61 35		1.8	31	439 285	
		5/1 1200	68 50 59 37		3.0	5	407	
		4/21	48 49 32		1.2	13	8.20 192 407 265	47 16 5.3 1.8 234 33
		1977 4/14 1645	30 45 inst		1,5 set	26	380 247	
		11/30	32		ice	ice	428 278	
	R 7W	1976 10/27 1215	30 36 1ce		2.3 set	9	425 276	
Little Basin	Location: S 1 T 13S R Water Year: 1977	Date Time	Temperature (F°) air water water (max)	Precipitation (in)	Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (µmhos) TDS (mg/1)	Ca Mg Na HCO SO <sub>4</sub> NH4  NO <sup>4</sup> SO <sub>4</sub> NO <sup>4</sup> NO <sup>4</sup> Ortho) -P "

Biological Character
Total Coliform
(colonies/100 mls)
Fecal Coliform
(colonies/100 mls)
Stock present



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Station: Little Basin Location: S 1 T 13S R	R 7W			•		Stream Reach Survey Date:	Stream Reach Score: 67 Survey Date: 8/16/76
	6/23	7/12	7/26	8/29 1200	9/17	9/27	
	72 64 72 48	67 57 75 48	57 77 50 50	57 73 43	7 8 7 T	660 52 38	
	1.3	.71	.78	.85	1.9	1.9	
	'n	28	2.5	2 2	< > >	<b>&gt; &gt;</b>	
Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	8.39 184 415 270	356 231	8.07 187 382 248	8.51 149 318 207	354 230	8.39 172 362 235	·
	49 16 7.8 1.3 225		51 17 9.0 1.7 229	51 18 6.9 1.4 172		60 21 7.5 1.8 210 28	
	<ul><li>6.01</li><li>6.01</li><li>.006</li></ul>		<b>~. ~.</b> 01 034	.02 .08		900.	
Biological Character Total Coliform (colonies/100 mis) Fecal Coliform (colonies/100 mls) Stock present	r 5 7	5	<b>6</b> 6 2	7 7 u		4 W	



		5/26 1845	47 55 64 33		3.0	12	8.25 184 378 246	45 15 9.8 1.5 1221	.01	1865	2 2 3
: 67	8/16/76	5/10	46 37 33 33		0.4	22	352 229				а
Stream Reach Score:	Survey Date:	5/4 1130	31 37 51 32		9.6	37	385 250				c
Str	Sur	4/26	43 54 32		6. 6 8. 8	35	7.71 152 300 195	41 11 8.4 1.7 183	.01	2650	e
		4/19	45 41 52 32		1.3	15	415 270				c
		4/12	37 38 32		5.2	23	. 322				g
		1978 4/4 1045	39 37 inst		1.6 set	7	330 214				g
1		11/13	42 47 32		ice	30	7.80 171 373 242	60 19 6.8 1.4 · 209	. 09 T	6	< 2 u
	11	1977 10/15 1815	55 53 33		1.8	٧ ٧	7.85 165 375 244	59 20 7.2 1.5 201 30	.03	2	n 2
Little Basin	Location: S 1 1 135 N /W Water Year: 1978	Date Time	Temperature (F°) air water water (max) water (min)	Precipitation (in)	Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/1) SC (umhos) TDS (mg/1)	Ca Mg Na Na HCO SO <sub>4</sub>	NH, NO, 6 NO, -N '' PO, (Ortho) P ''	Biological Character Total Coliform (colonies/100 mls)	recal Colliform (colonies/100 mls) Stock present

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BASIC DATA RECORD



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core: 67	8/16/76	9/11	41 44 63 38		2.7	17	8. 158 408 265	48 16 6.8 2.6 188		9100 43
Stream Reach Score:	Survey Date:	8/14	50 50 69 47		1.8	54	8.45 178 420 273	52 17 6.4 0.96 211 31	.002	3400 30
St	Su	7/19	61 62 70 46		1.8	11	8.20 171 387 252	47 17 7.6 1.3 209 31	.18	15800 106 u
		6/27	69 63 67 41		3.0	17	382 248			g.
		6/19	63 57 65 41		3.0	20	8.38 180 377 245	48 19 9.5 1.3 216	6.01 6.01 .034	9530 6
		6/14	65 69 41		2.5	18	362			s
	-	6/8 1030	61 52 68 37		2.6	22	399			g.
7.0		5/31	45 50 62 37		9.6	24	383 249			а
77	Water Year: 1978	Date Time	Temperature (F°) air water water (max) water (min)	Precipitation (in)	Discharge (cfs) instant crest stage	Suspended sediment (ppm)	Chemical Character PH ALK (CaCO <sub>3</sub> ) (mg/l) SC (µmhos) TDS (mg/l)	Ca Mg Na K HCO SO <sub>4</sub>	NH, NO4, 6, NO3 -N '' PO2, (Ortho)-P ''	Biological Character Total Coliform (colonies/100 mls) Fecal Coliform (colonies/100 mls) Stock present

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